INFINITE ENERGY™

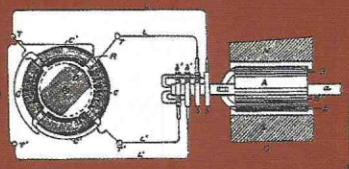
The Magazine of New Energy Technology

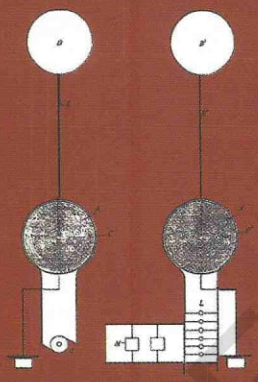
New Energy • New Science • New Technology

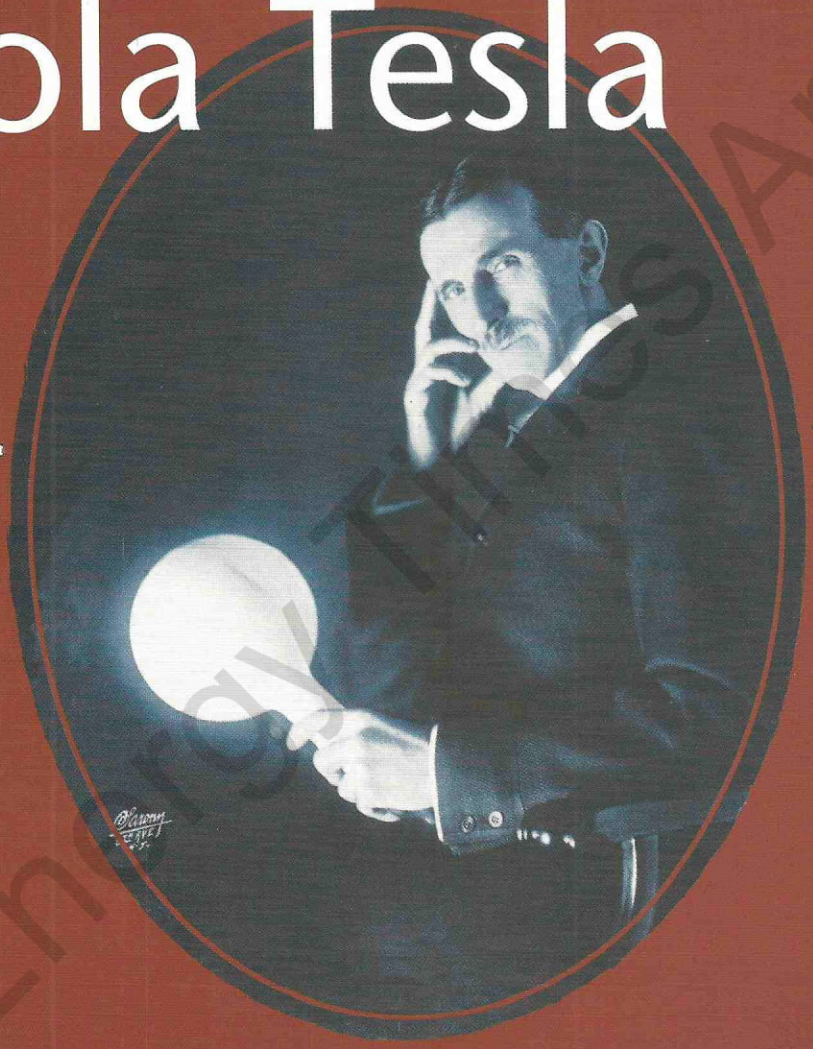
Volume 8 • Issue 48 • 2003

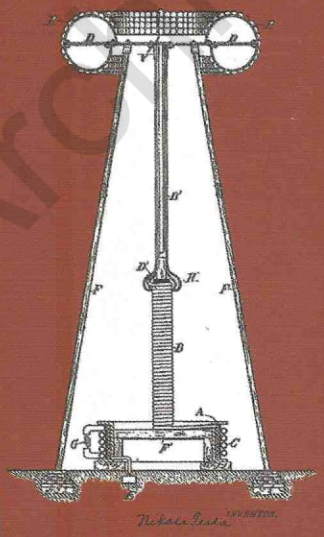
Celebrating

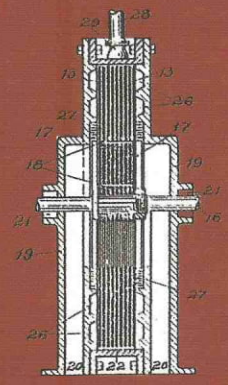
Nikola Tesla











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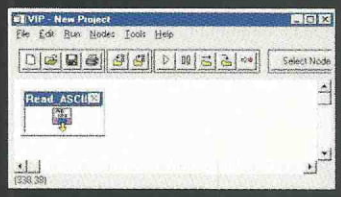

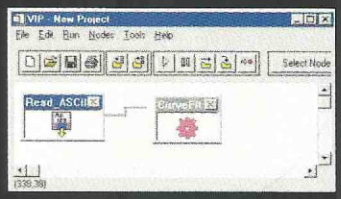

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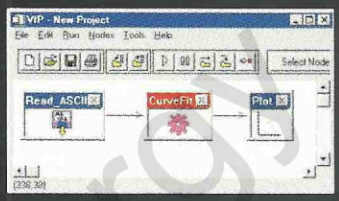

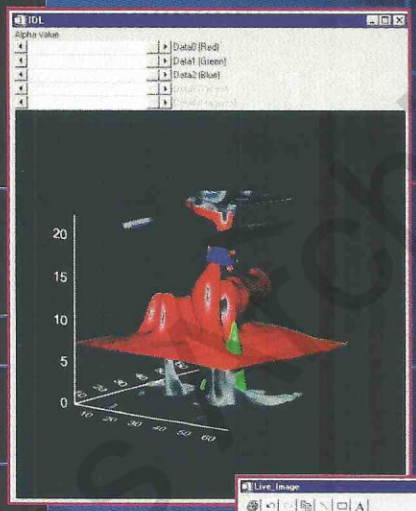

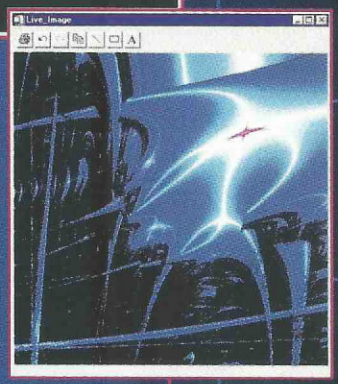

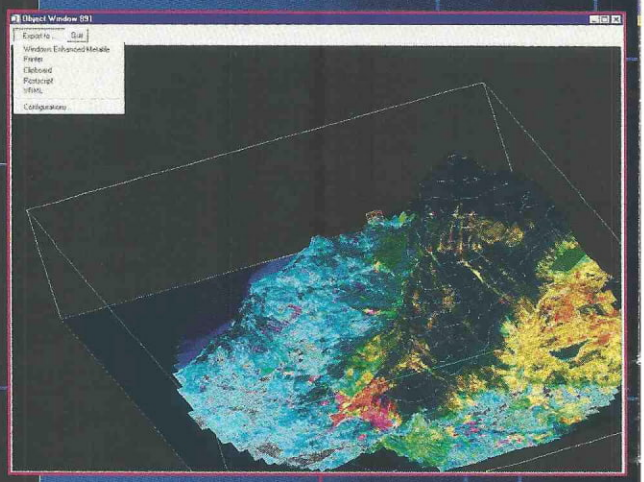

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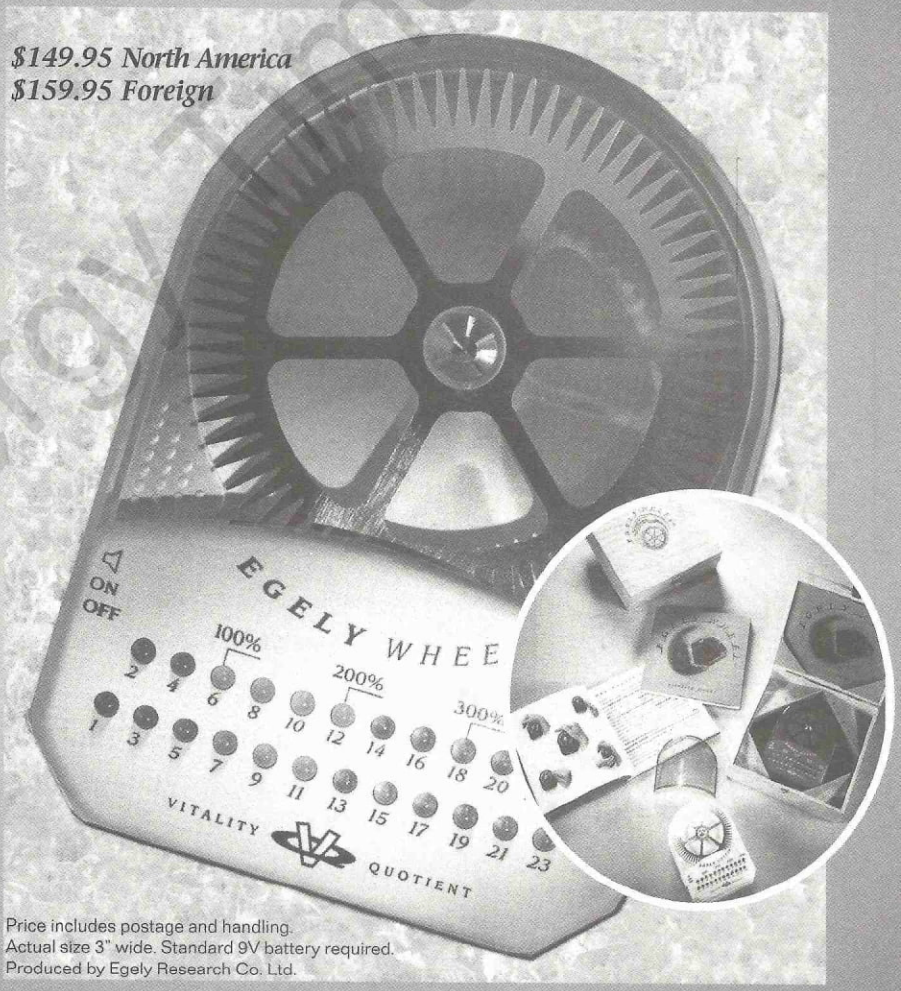

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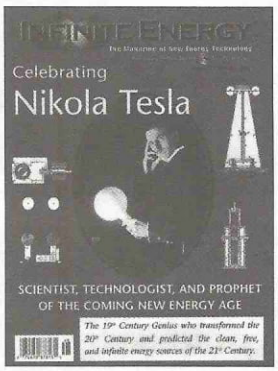

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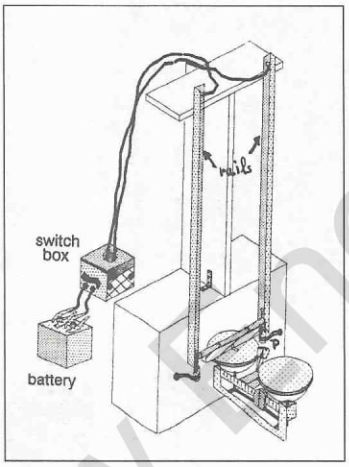

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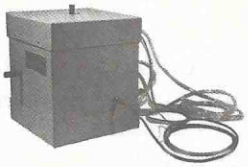

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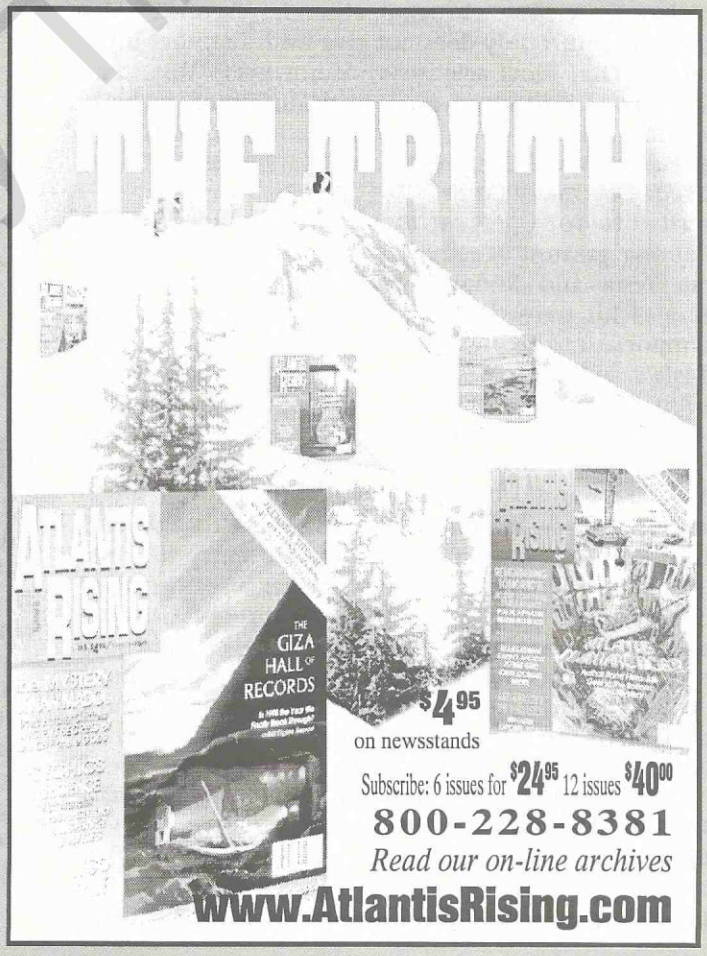

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LETTERS TO THE EDITOR

Tesla and Steiner

After reading a great many alternate press publications, I stumbled onto yours. It is a great idea to try to get off our use of oil, or better, "burn technology." It is a big step in the right direction when the aether is identified as mass free energy. It seems, however, that a philosophical base is needed for further improvement or advancement of these kinds of concepts.

The old Mystery school concept taught the concept of mass free, or in their words, *spirit* beings. It is hard to imagine a mass free energy without the presence of a mass free being! This, then, would have to be the world of the Gods, stated in modern language. A framework on all of this was provided by Rudolph Steiner. He made many contributions to society, covering many fields. To him, *mass free would be spirit*, with all its attendant consequences. One should read his light and warmth courses to get a feel for his method of thinking.

In his light course, Steiner shows how electricity as we know it is an effect. There is something behind the electrical world. He cites how lightning is a tearing apart of three-dimensional space. He also talks about four "ethers" that work on the planet. It looks like everyone focuses on what Steiner called the "chemical" ether, while ignoring the other three. The chemical ether is responsible for magnetism. It certainly does not give forth life; that is the life ether. That most scientists cannot grasp this is an indication of the lack of framework on which to build their understanding. Steiner's contribution to biodynamic agriculture shows his mental flexibility. These are used to this day on many farms.

So what to do? I propose that a link be made between two of the greatest scientists of the twentieth century, Nikola Tesla and Rudolph Steiner. Tesla was chosen because of his trained will. The training of the will was very important to Steiner. You can read how this was done in Tesla's autobiography and in *Enigma Fantastique* (Gordon Allen). The latter book is an excellent joining of the two minds. To put it simply, we have a technology based on fire, because it is easy to grasp its principles. We do not have a world based on the tearing apart of three-dimensional space, because one must believe that there is another world, a mass free world, to gain entry to. Tesla and Steiner lived in such worlds. Steiner also identified the source of all the hostility that was directed at those engaged in such works. The Mystery schools of old would have also identified the source. Hint: it would be a mass free being. Tesla, in his autobiography, says that most people respond to impulses as though the impulses were of their own creation. In reality, the impulses were not of one's own creation. Only a mind trained in detecting such impulses would know the difference. This appears to be how the game of life is played.

So, I believe it is time for the learned people of the world to join these two great minds together. Then, we should be able to make progress not only in the energy sphere, but in the social sphere as well.

Tom Batorski
Angola, New York

Website a Good Reference

I greatly appreciate all of the work that is involved with producing your excellent magazine. I must confess that some of the articles are over my head technically. However, I am still able to benefit from the thrust of what you are doing. And finding new energy sources to replace fossil and nuclear is crucial for the future of society. Your magazine gives me a front row seat in following progress on this front.

From time to time I have occasion to refer a skeptic to your homepage (www.infinite-energy.com) to read the cold fusion letter by Dr. Mallove to President Clinton. I hope you will continue to retain this valuable resource on your website. When I get challenged on the background to new energy, I cite your letter as one of my reference documents. Unfortunately, I cannot say that the majority can grasp the full significance of its message, but I keep trying.

Bertram Cohen
Poughkeepsie, New York

Big Bang Bashing

Congratulations on *Infinite Energy* #46. How pleased I was to see a bashing of the Big Bang model. We all appreciate your long-term devotion to new ideas.

John O'M. Bockris
College Station, Texas

Hooray! My layman's suspicions are confirmed. They began while viewing a laudatory documentary on the Hubble telescope. When pointed at a "blank" piece of sky, Hubble revealed—surprise, surprise—more galaxies. To me, that suggested microwave cosmic background radiation was the collective noise of our infinite home, rather than a remnant of a past cataclysm. *IE's* cover story (#46, "The Big Bang Busted") has reassured me that my heresy is not unique.

The Big Bang myth also unwittingly reveals our human desire for book-ended singularities, such a Theory of Everything where something *has* to equal something else. Since all manner of matter and energy exists in relation to its neighbor, aren't existing ratios an already appropriate form of measurement? But that is like saying that not only does the emperor have no clothes, he shouldn't even be an emperor.

Peter Ness
Bardwell Valley, NSW, Australia

New Energy Times Archive

Nikola Tesla: Man of Three Centuries

by Eugene F. Mallove, Sc.D.

Near midnight between the 9th and 10th of July, 1856, Nikola Tesla was born of Serbian parents in Croatia near Bosnia, an area that has known centuries of turmoil. From such a humble beginning came a *Man Out of Time*—almost literally—the title of Margaret Cheney's 1981 biography of Tesla. The eccentric genius who would grow from this infant was a man rooted in the nineteenth century's scientific revolutions of electricity and magnetism. His electrical creations would transform the twentieth century beyond recognition—widely distributed electricity that would dominate all aspects of life and a society pervaded by global "etheric wave" communication, radio, and television. Nikola Tesla's legacy has not yet come to full bloom, but it surely will in this, the twenty-first century, which (one hopes!) will be much less recognizable to twentieth centurians than the twentieth century was to be to the Victorians.

We celebrate Nikola Tesla in this *Infinite Energy*, in large part by reprinting, with annotation and commentary, his astonishing prescient article, "The Problem of Increasing Human Energy." It appeared in the June 1900 issue of *Century* magazine, thus nicely demarcating with Tesla's predictions the two centuries of his *living* reign. We offer brief eclectic tours of some of the better-known Tesla biographies, and we touch on a notable Tesla video documentary/dramatization.

Tesla had come to the U.S. in 1884 with a letter of introduction to Thomas Edison—from Charles Batchelor, the British engineer who ran the Continental Edison Company in Europe. The two towering figures, Edison and Tesla, had a very brief working relationship in America, but their manners, personalities, and approaches to commercializing the generation and transmission of the electrical "fluid" clashed dramatically. Edison would remain stuck with the problematic direct-current paradigm, while Tesla had long envisioned his polyphase alternating current approach, which he invented down to its many particulars. Tesla won, of course, yet in 1943 he died in the New York hotel room in which he lived, in debt and in abject poverty. He was a visionary scientific genius, not a savvy, cut-throat businessman. To this day, Tesla does not receive the credit he deserves. Though he was the true discoverer of the basic methods of radio communication (as later formally adjudicated in a U.S. Supreme Court decision following Tesla's death), popular history grants the honor of radio's invention to Marconi, who had used Tesla's ideas. Tesla knew of that interference at the time, but he just smiled; he was too immersed in his other overarching plans for energy and communication.

The U.S. Smithsonian Institution to this day does not properly credit Tesla for the invention of radio! Tesla these days is not only "mystified" and mythologized by hordes of devotees, he is also maligned by the scientific bigots of CSICOP (the so-called Committee for the Scientific Investigation of Claims of the Paranormal). The CSICOPers cannot abide Tesla's visions of the possible, so stuck are they in their archaic textbook understanding of basic physics, from which they refuse to budge.

The nineteenth century Tesla's dashing persona and evident genius, his over six-foot tall, thin frame, his dark complexion, and fluency in many languages endeared him to many movers and shakers, artists, writers, and musicians of that period—among them J. Pierpont Morgan (a significant investor in the Edison Electric Light Company), George Westinghouse (who would make his fortunes from Tesla's towering intellect), John D. Rockefeller, author Mark Twain (Samuel Clemens), and French Actress Sarah Bernhardt. And there was admirer Katherine Johnson, whose husband Robert Underwood Johnson ran *Century* magazine—the venue of Tesla's 1900 exposition on the future of energy and many other technologies, including robotics and futuristic military machines.

It is a little over a century after much of our world began to have access to widely distributed electric power, thanks to the pioneering by Nikola Tesla of polyphase alternating current—the basic methods of its generation and transmission. This began in 1896 with the generation of electricity at Niagara Falls and its transmission to other parts of New York. New York City quickly became the intense luminous beacon that it remains today. But Tesla's plans were far greater than could be contained in copper wires. He wanted to launch a world of free energy—one in which electric power could be tapped by anyone at any point on Earth via "wireless transmission." Despite that great genius's mostly unrecognized impact on civilization, an era of free energy did not break out in the twentieth century, though it might have; Tesla's hopes were put on hold.

Tesla's famous 187-foot Wardenclyffe transmission tower on Long Island was erected in 1903. Its' ostensible purpose had been for global radio communication, but

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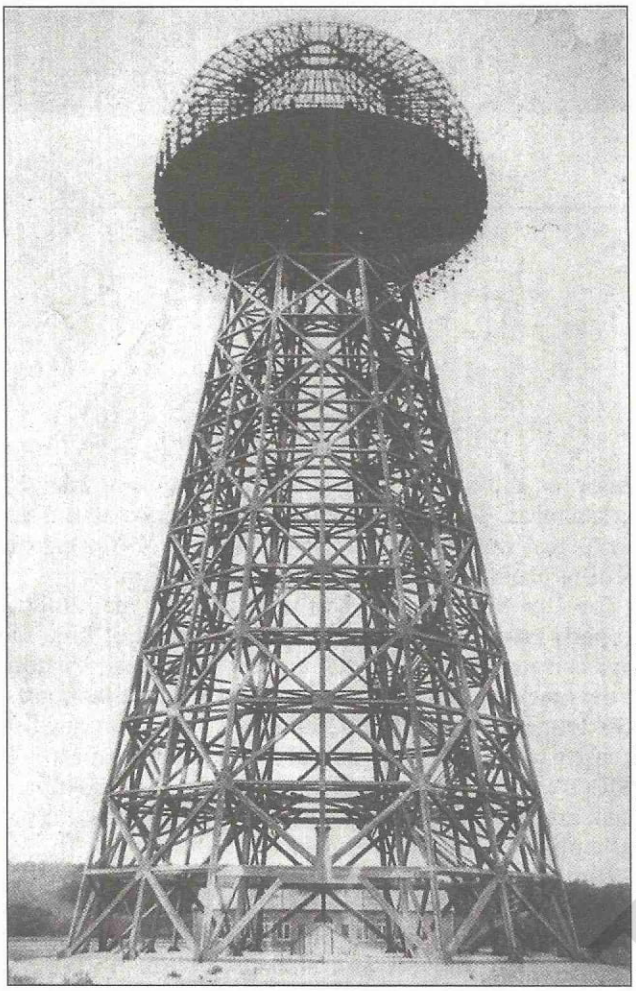

Photo courtesy of the Tesla Wardenclyffe Project.

Tesla's Wardenclyffe tower.

Tesla's driving ambition for it had been to launch wireless power transmission as well. This was not to be, whether or not his technical ideas had merit—and in this case they may have been flawed. Financial reversals and other problems led to the tower's destruction; it was sold for scrap in 1917. But the quest for free energy did not die. Just as there had been many failed aeronautical pioneers toward the latter part of the nineteenth century, so there were to be many failures in the quest for free energy—and some near-miss successes—throughout the twentieth century.

A little less than one hundred years ago, two bicycle mechanics showed that the scientific establishment was dead-wrong about the "impossibility" of heavier-than-air flight. Tesla was one of those in 1900 who believed that the airplane was coming—and soon. He was right. On December 17, 1903, Orville and Wilbur Wright burned their names into history at Kitty Hawk, North Carolina, though it took five more years—not until late 1908 with a flight demonstration at Ft. Myer, Virginia—for the Establishment's media organs even to acknowledge that the Wrights had pulled off a scientific and technological coup. Even the great Tesla did not know of the Wrights' accomplishment at the time (1903). Following the Wrights' seminal achievement, the next hundred years witnessed a revolution in transportation and commerce. Then astronautics built upon aviation with explosive technology—giving rise to communications satellites, weather satellites, and voyages to the Moon, planets, asteroids, and comets. Space exploration has been severely hampered, to be sure, by the lack of an energy source much more potent than chemical combustion, and spaceflight has been saddled by a restrictive physics that is built on the shakiest of foundations. That is about to change, with a revolution in electricity that has a lot to do with the fundamental physics of the universe.

Though we have seen many dead-end detours on the road to free energy, it may be that 2003 will mark the beginning of a turning point in that journey. Victory is long overdue. Today, many solid strands of research in free energy are coming together, and the final triumph of limitless, clean energy is very much within reach. In fact, sad to say, the primary ingredient holding back a raging breakout of a new energy revolution is R&D money—in the right hands, of course! Foremost among the hopeful developments in new energy is the recognition of the work of Tesla himself, though free energy will not come in the way the great inventor had planned it. Most likely there will be no generalized wireless transmission of power, but there will be free energy tapped from the vacuum state—the aether—at countless distributed sites with compact free energy devices. Thus, the inevitable end of the power-grid—just as Tesla had envisioned. This is in the process of happening as legitimate dynamic aether physics is recovered by more and more investigators from the impending wreckage of Einsteinian relativity and its fiction of the "nothingness" of so-called "space-time."

Let us review where things stand on the free energy front in early 2003. A good beginning is to examine our newly posted New Energy Frequently Asked Questions (FAQ) on www.infinite-energy.com, with its highlighted important scientific links. Here is a brief summary:

We have many times drawn the attention of those readers with a more mathematical physics bent to the compendious work of Dr. Paulo and Alexandra Correa on their www.aetherometry.com website. There one will find at least *one* coherent view of precisely how matters went astray, beginning in the nineteenth century, and continuing with the many limiting fictions under which physics still labors. If one does not care to probe the details, but wants to see prototype plasma power and self-sustaining aether motors in operation, there is now a 100-minute DVD, "From Plasma Power to the Aether Motor," which can be ordered. Dr. Harold Aspden, an aether theorist himself and former director of IBM's European patent operations (from 1963 to 1983), introduces the Correa technology by describing how electromagnetic theory went astray as early as the 1820s! Seeing the DVD may not exactly bring one to "believing," but it is the next best thing. Testimonials based on hands-on testing and familiarity with the physics and its discoverers, is that this technology is for real—there is no hanky panky involved, no concealed batteries, etc. This is the first time in the quest for free energy from the aether that such pedigreed devices have appeared in accessible public view.

No less than three types of free energy technologies are displayed in operation and testing: 1) The mid-1990s patented pulsed plasma power Pulsed Abnormal Glow discharge (PAGD™) reactor devices, powering spinner motors and spinning up flywheels (50 watts of DC electricity in, 500 watts mechanical power out); 2) Patent-applied-for

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self-running Aether/ORgone Motor-Converter technology, stemming from the work of Nikola Tesla and Wilhelm Reich, but going far beyond—motors that are driven by aether energy captured with "orgone accumulators," by vacor (evacuated) glass tubes, and even by ungrounded human bodies, and 3) Stirling motors driven not by fuel combustion, but operated anomalously from a hybrid orgone accumulator chamber during both daylight and deep into a cold Canadian night. The pioneering documentary is filled with simple demonstrations of massfree aether energy—from the vacuum, the ground, the atmosphere, and human bodies. This illustrates the existence of an energy realm which has heretofore been both ignored and grossly misunderstood. Yes, there is an intimate connection between physics and biophysics—as some of the more effective complementary medical approaches have long suggested. "Qi" energy is not just some "New Age" term; it's for real, and its physics can increasingly be understood—and measured—qualitatively and quantitatively.

This is most important, for what is more necessary than a proper understanding of the true boundary conditions of biological systems—our existence? The current paradigm suggests this biology to be conceptually "exclusively biochemistry." But is there really any mainstream research that confirms "biophysical energy"—an energy that attends and augments and interpenetrates "biochemistry"? There are significant controlled studies that substantiate the effectiveness of complementary medicine modalities, such as acupuncture and "healing touch"-type therapies. However, we are increasingly seeing Western medicine's technological imaging and sensing devices being applied to prove that bodily effects without conventional biological explanation are occurring. To cite one of the best examples we have encountered, please examine: "Evaluation of Acupuncture Using fMRI and Ultrasonic Imaging," by Chang Sok So (Dept. of Anatomy and Neurobiology), Joie P. Jones and David D. Kidney (Department of Radiological Sciences), University of California at Irvine; Takuso Saito, Tokyo Institute of Technology, a paper given at the Society for Scientific Exploration in June 2001 in LaJolla, California. But much of this is also published by the authors in *Proceedings of the National Academy of Sciences USA*, Vol. 95, 1998, pp. 2670-2673. In this study, it is conclusively shown with scientifically blinded examination using ultrasonic and other stimulation of an acupuncture point in the foot of a subject (many subjects were used): 1) The acupuncture point on the foot, known by acupuncturists to help vision when stimulated, resulted in nearly instantaneous production of activation in the visual cortex of the brain of the subject—a completely reproducible effect that could be toggled off and on; 2) The acupuncture point was found to be highly localized (within a fraction of a millimeter); and 3) The speed of transmission of the information from the foot acupuncture point to the visual cortex of the brain, as measured by fMRI, was at least 1,000 times any known nerve transmission speed! Dr. Joie P. Jones explained, at a public lecture in June 2001 (Society for Scientific exploration Meeting, LaJolla, California), that because the functional MRI (fMRI) minimum time localization of measurement is about 80-microseconds, the actual transmission speed to the brain might be faster than even this astounding 1,000-fold figure. What kind of "only biochemistry" can do that?

A footnote, which illuminates the sad state of mainstream science today: The group's technical paper, which is obviously of overarching importance, was submitted to *Science*, and then *Nature*, which both rejected without review—according to Dr. Joie Jones. Subsequently, five sympathetic Nobel laureates in the biological sciences, who were impressed with the paper, urged *Nature* to reconsider its decision. It did not. Therefore, the paper had to be published in the *Proceedings of the National Academy of Sciences*, which does not censor the work of its participants. Thus, a fundamental finding about the human body's functioning, and the medical effectiveness of a disparaged technique—acupuncture—has been submerged, at least for now. *Infinite Energy* is bringing it to you.

Now for "cold fusion," the indisputably verified—and most widely validated of the emerging free energy technologies. The field is more properly referred to as LENR—Low-Energy Nuclear Reactions. In effect, the science has become modern alchemy. The transmutation of heavy elements is shown to occur with remarkable ease in certain systems. Examine www.lenr-canr.org for the latest downloadable technical papers in this area. Though LENR technological energy devices appeared to be imminent in the mid-1990s, various materials problems with thin-film metal coatings in electrochemical cells produced a severe setback. Now new gas-type "catalytic fusion" cells are showing much greater promise. Furthermore, the offshoot from cold fusion launched by Dr. Randell Mills in 1991, a kind of new hydrogen physics revision of modern quantum mechanics, appears to be blossoming at the well-funded BlackLight Power Corporation in New Jersey (see www.blacklightpower.com). Dr. Mills and his colleagues have just had an article published by the *American Journal of Physics* (December 2002)—a sign of the establishment cracking perhaps? The most noteworthy accomplishment of BlackLight Power is the *highly reproducible* excess heat phenomenon in gas plasma systems—much more reproducible, and *predictable* by gas component selection criteria, than LENR phenomena.

Though Randell Mills on the one hand and the cold fusion/LENR community on the other are convinced of their separate theoretical justifications, neither should be so self-satisfied and secure. An underlying new physics of some kind almost certainly straddles the whole of anomalous energy—the new energy field.

In "Eclectic Observer" in our last issue, we highlighted some marvelous developments by professors of physics and mathematics at the University of San Diego in what we will begin to call "Environmental Energy"—to be slightly "scientifically-politically correct," rather than blurt out "macroscopic violations of the Second Law of Thermodynamics." The October 2002 article in *Foundations of Physics* by Professors Sheehan, Putnam, and Wright is "A Solid State Maxwell Demon." Yes, the advent of possible Macroscopic Maxwell Demons is at hand. These harnessed Demons will terrorize the Physics Establishment, once it stops laughing in denial of the prospect. It is thrilling to realize that Nikola Tesla predicted the advent of this "cold hole" phenomenon even in his time: engines which could work by preserving

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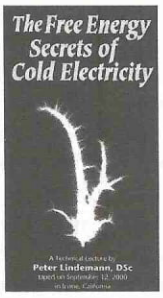
against diminution a localized cold region, a "cold hole," into which heat from the environment would "fall" with attendant generation of work. He wrote that he conceived this in 1883! In other words, if the carefully simulated Sheehan *et al.* device is realized, an "impossible" Perpetual Motion Machine of the Second Kind is possible. All hell will break loose when the unleashed Maxwell's Demons run wild!

This completes a summary of the three-pronged assault on "business as usual" in science that new energy field represents. But do not forget that—with the exception of "cold fusion," the basic form of which Tesla could not have foreseen, the great man anticipated it all, and it's about time—2003, a century after Tesla's Wardenclyffe.

The Free Energy Secrets of Cold Electricity Video and Book Available



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NTSC or PAL Format
$29.95 Domestic
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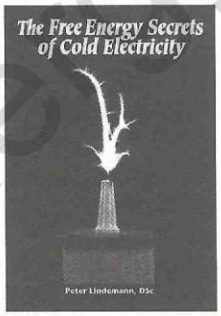
The video **is a technical lecture (September 12, 2000) by Dr. Peter Lindemann. A coherent discussion of the possible connections between free energy claims by inventor Edwin Gray in the 1970s-1980s and the much earlier alleged "free" energy broadcasting ideas of Nikola Tesla. Those who experiment and speculate about energies connected with arc discharges and lightning will find in this material highly creative hypotheses.**

The book **is a wonderful companion to the video. Covers the same material, but goes beyond the video in its publication of text and graphics, making it possible to do detailed study. Appendices include patents by Edwin Grey and Nikola Tesla, as well as two excellent articles by Dr. Lindemann.**



Paperback, 133 pp.
$29.95 Domestic
$39.95 Foreign

Prices include shipping and handling.

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Errata

Robert Nelson's "Oil from Coal—Free! The Karrick LTC Process" in Issue 46 (pp. 34-39) transmitted an error from a reference used by the author. Based on reference material, Nelson indicated that the National Coal Carbonizing Company (NCCC) utilized the Karrick process for forty years. Nelson has since learned that the NCCC actually used a similar process patented by Wallace/Davis (U.S. Patents 1,491,290 and 1,536,696), not the Karrick process.

In Issue 47, David Moon's paper, "The MODS Theory of Cold Fusion Can Explain Tungsten Cathode Plasma Electrolysis" (pp. 25-27), contained an error on the first page. Equation 2 should have read as follows:

$$p + e^- + E \rightarrow n^* + \upsilon$$

Infinite Energy inadvertently omitted the asterisk from the equation.

In Issue 47, the paper by Alex Andrew Florey ("Space Quantum and Consequences," pp. 29-31) contained a misprinted figure. The image in Figure 2 (p. 30) was a duplication of the one in Figure 3. The Figure 2 caption was correct, but the image was not correct. Below is the correct Figure 2 image, with the caption reprinted for clarity.

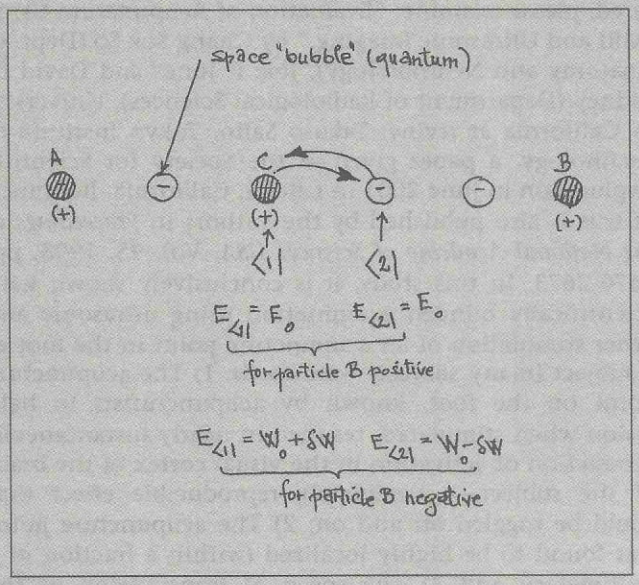

Figure 2. In a situation like this, there is no conventional center for the "interval" A-B. The two positions, <1| and <2|, are equal candidates for that function, therefore the system in this figure becomes a system with two base states, <1| and <2|. If we remove particle C from the system, the asymmetry would persist, raising the suspicion that AB is a two base state system solely for reasons of principle (the restoration of symmetry).

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Editor's Introduction

This extraordinary article by the great scientist and inventor Nikola Tesla originally appeared in Century Illustrated Monthly Magazine in June 1900. We are pleased to reprint it here—with annotations and commentary—to link it with events, ideas, science, and technologies of 2003. Tesla's great insights expressed over a century ago about the future of energy are a testament to his genius and enduring greatness. Some of Tesla's thoughts from a bygone era are, to be sure, eccentric, quaint, amusing, and dated.

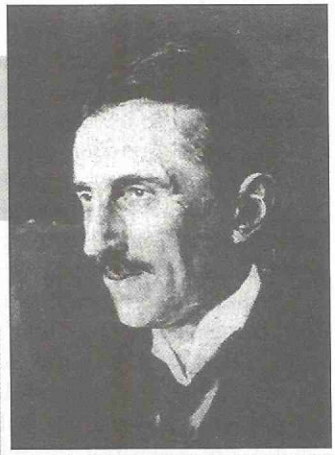
—Eugene Mallove

The Problem of Increasing Human Energy

With Special References to the Harnessing of the Sun's Energy

by Nikola Tesla

Annotation and commentary by Eugene F. Mallove



The Onward Movement of Man, the Energy of the Movement, and the Three Ways of Increasing Human Energy

Of all the endless variety of phenomena which nature presents to our senses, there is none that fills our minds with greater wonder than that inconceivably complex movement which, in its entirety, we designate as human life; its mysterious origin is veiled in the forever impenetrable mist of the past, its character is rendered incomprehensible by its infinite intricacy, and its destination is hidden in the unfathomable depths of the future. Whence does it come? What is it? Whither does it tend? are the great questions which the sages of all times have endeavored to answer.

Modern science says: The Sun is the past, the Earth is the present, the Moon is the future. From an incandescent mass we have originated, and into a frozen mass we shall turn. Merciless is the law of nature, and rapidly and irresistibly we are drawn to our doom. Lord Kelvin, in his profound meditations, allows us only a short span of life, something like six million years, after which time the Sun's bright light will have ceased to shine, and its life giving heat will have ebbed away, and our own Earth will be a lump of ice, hurrying on through the eternal night. *[In 1900, the concept of nuclear reactions powering the stars was, of course, unknown, though the then still-mysterious radioactivity had been discovered in 1896. And today's theories of stellar evolution suggest that the Sun will shine brightly for billions of years—but not before melting Earth's surface in an inferno billions of years hence, as the Sun expands in its presumed "red giant" phase. As for Earth itself and the Moon—and the other planets—their internal heat sources remain a mystery in 2003, clouded by confusion and debate. The recent cover story of the science magazine Discover suggests that there is a natural nuclear fission reactor at Earth's core, whereas heat from radioactivity dispersed through the body of the Earth is, in the mainstream view, the source of Earth's internal heat! The mainstream has not yet embraced Low-Energy Nuclear Reactions, which emerged in the "cold fusion furor" beginning in 1989, later confirmed, and which might yet offer explanations for the internal heating of "cold" celestial bodies.—EFM]* But do not let us despair. There will still be left upon it a glimmering spark of life, and there will be a chance to kindle a new fire on some distant star. This wonderful possibility seems, indeed, to exist, judging from Professor Dewar's beautiful experiments with liquid air, which show that germs of organic life are not destroyed by cold, no matter how intense; consequently they may be transmitted through the interstellar space. *[Theories of interstellar panspermia were later pioneered by Swedish chemist Svante Arrhenius (1859-1927), who in his 1908 book Worlds in the Making suggested that spores pushed by sunlight through the vast reaches of space might have been the source of life's origin on Earth (though this would still not explain where life originated in the first place).*

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Later in the twentieth century, in the era of spaceflight, came the idea that Earth and other planets might have been deliberately "seeded" by extraterrestrial civilizations.—EFM] Meanwhile the cheering lights of science and art, ever increasing in intensity, illuminate our path, and marvels they disclose, and the enjoyments they offer, make us measurably forgetful of the gloomy future. *[The technologically optimistic Tesla had no idea of just how gloomy human affairs might become in the twentieth century! It became an era of profound scientific discovery and change, but also one of terrible cruelty—and of mass murder and slavery on a theretofore unimaginable scale. And surely Tesla had no idea how rigid and unaccepting of new ideas about new sources of energy the scientific world would become in the mid-to-late twentieth century.—EFM]*

Though we may never be able to comprehend human life *[Here Tesla reveals the mystical thinking of science in that era about life, which had yet to reveal some of what we know in 2003 of the biochemical structure and functioning of life, and its genetic structure. And, he could not know that the pathwork on aether energy technology that he was pursuing would eventually lead to deep insights about a major component of biological function—the biophysical action of an energetic aether.—EFM],* we know certainly that it is a movement, of whatever nature it be. The existence of movement unavoidably implies a body which is being moved and a force which is moving it. Hence, wherever there is life, there is a mass moved by a force. All mass possesses inertia, all force tends to persist. Owing to this universal property and condition, a body, be it at rest or in motion, tends to remain in the same state, and a force, manifesting itself anywhere and through whatever cause, produces an equivalent opposing force, and as an absolute necessity of this it follows that every movement in nature must be rhythmical. Long ago this simple truth was clearly pointed out by Herbert Spencer, who arrived at it through a somewhat different process of reasoning. It is borne out in everything we perceive—in the movement of a planet, in the surging and ebbing of the tide, in the reverberations of the air, the swinging of a pendulum, the oscillations of an electric current, and in the infinitely varied phenomena of organic life. Does not the whole of human life attest to it? Birth, growth, old age, and death of an individual, family, race, or nation, what is it all but a rhythm? All life-manifestation, then, even in its most intricate form, as exemplified in man, however involved and inscrutable, is only a movement, to which the same general laws of movement which govern throughout the physical universe must be applicable.

When we speak of man, we have a conception of humanity as a whole, and before applying scientific methods to the investigation of his movement, we must accept this as a physical fact. But can anyone doubt today that all the millions of individuals and all the innumerable types and characters constitute an entity, a unit? *[Though the "entity" of Humankind may not be so very coherent and unified in the early twenty-first century, the more extended underlying scientific unity among all living beings and their fragile environment are in 2003 seen in discussions of "Gaia" and concern for the planetary environment.—EFM]* Though free to think and act, we are held together, like the stars in the firmament, with ties inseparable. These ties cannot be seen, but we can feel them. I cut myself in the finger, and it pains me: this finger is a part of me. I see a friend hurt, and it hurts me, too: my friend and I are one. And now I see stricken down an enemy, a lump of matter which, of all the lumps of matter in the universe, I care least for, and it still grieves me. Does this not prove that each of us is only part of a whole?

For ages this idea has been proclaimed in the consummately wise teachings of religion, probably not alone as a means of insuring peace and harmony among men, but as a deeply founded truth. The Buddhist expresses it in one way, the Christian in another, but both say the same: We are all one. Metaphysical proofs are, however, not the only ones which we are able to bring forth in support of this idea. Science, too, recognizes this connectedness of separate individuals, though not quite in the same sense as it admits that the suns, planets, and moons of a constellation are one body, and there can be no doubt that it will be experimentally confirmed in times to come, when our means and methods for investigating psychical and other states and phenomena shall have been brought to great perfection. *[In 2003, intense scientific controversy still swirls around "psychical phenomena." The apparent experimental validation of the non-localized nature of consciousness (e.g. the work of Prof. Robert Jahn and associates at Princeton University, beginning in the 1980s) means nothing to the bigoted "scientific establishment" of 2003. If Tesla were to divulge his interest in psychical phenomena today, he would be ridiculed and abused. What a different time Tesla lived in!—EFM]* Still more: this one human being lives on and on. The individual is ephemeral, races and nations come and pass away, but man *[And woman!—EFM]* remains. Therein lies the profound difference between the individual and the whole. Therein, too, is to be found the partial explanation of many of those marvelous phenomena of heredity which are the result of countless centuries of feeble but persistent influence. *[In 2003, we know much about heredity and heritable characteristics. But still, as in Tesla's less knowledgeable time, we are confronted by lingering mysteries and debates (among those who accept the basic premise of biological evolution) about just how sometimes "acquired characteristics" may be passed on biochemically or microbiologically—new challengers to the purely natural selection paradigm of Darwin.—EFM]*

Conceive, then, man as a mass urged on by a force. Though this movement is not of a translatory character, implying change of place, yet the general laws of mechanical movement are applicable to it, and the energy associated with this mass can be measured, in accordance with well-known principles, by half the product of the mass with the square of a certain velocity. So, for instance, a cannon-ball which is at rest possesses a certain amount of energy in the form of heat, which we measure in a similar way. We imagine the ball to consist of innumerable minute particles, called atoms or molecules, which vibrate or whirl around one another. We determine their masses and velocities, and from them the energy of each of these minute systems, and adding them all together, we get an idea of the total heat-energy contained in the ball, which is only seemingly at rest. In this purely theoretical estimate this energy may then be calculated by multiplying half of the total mass—that is half of the sum of all the small masses—with the square of a velocity which is determined from the velocities of the separate particles. In like manner we may conceive of human energy being measured by half the human mass multiplied with the square of the velocity which we are not yet able to compute. But our deficiency in this knowledge will not vitiate the truth of the deductions I shall draw, which rest on the firm basis that the same laws of

mass and force govern throughout nature.

Man, however, is not an ordinary mass, consisting of spinning atoms and molecules, and containing merely heat-energy. He is a mass possessed of certain higher qualities by reason of the creative principle of life with which he is endowed. His mass, as the water in an ocean wave, is being continuously exchanged, new taking the place of the old. Not only this, but he grows propagates, and dies, thus altering his mass independently, both in bulk and density. What is most wonderful of all, he is capable of increasing or diminishing his velocity of movement by the mysterious power he possesses by appropriating more or less energy from other substance, and turning it into motive energy. But in any given moment we may ignore these slow changes and assume that human energy is measured by half the product of man's mass with the square of a certain hypothetical velocity. However we may compute this velocity, and whatever we may take as the standard of its measure, we must, in harmony with this conception, come to the conclusion that the great problem of science is, and always will be, to increase the energy thus defined. *[Tesla would be surprised to learn that in the late twentieth century there arose certain kinds of "environmentalists" who were bent on doing everything in their power to* ***reduce*** *the energy consumption of Humankind, not increase it. They feared and despised new sources of energy!—EFM]* Many years ago, stimulated by the perusal of that deeply interesting work, Draper's *History of the Intellectual Development of Europe,* depicting so vividly human movement, I recognized that to solve this eternal problem must ever be the chief task of the man of science. Some results of my own efforts to this end I shall endeavor briefly to describe here.

Let, then, in Diagram A, M represent the mass of man. This mass is impelled in one direction by a force f, which is resisted by another partly frictional and partly negative force R, acting in a direction exactly opposite, and retarding the movement of the mass. Such an antagonistic force is present in every movement and must be taken into consideration. The difference between these two forces is the effective force which imparts a velocity V to the mass M in the direction of the arrow on the line representing the force f. In accordance with the preceding, the human energy will then be given by the product $^1/_2\, MV^2 = {}^1/_2\, MV \times V$, in which M is the total mass of man in the ordinary interpretation of the term "mass," and V is a certain hypothetical velocity, which, in the present state of science, we are unable exactly to define and determine. To increase the human energy is, therefore, equivalent to increasing this product, and there are, as will readily be seen, only three ways possible to attain this result, which are illustrated in the above diagram. The first way shown in the top figure of Diagram A, is to increase the mass (as indicated by the dotted circle), leaving the two opposing forces the same. The second way is to reduce the retarding force R to a smaller value r, leaving the mass and the impelling force the same, as diagrammatically shown in the middle figure. The third way, which is illustrated in the last figure, is to increase the impelling force f to a higher value F, while the mass and the retarding force R remain unaltered. Evidently fixed limits exist as regards increase of mass and reduction of retarding force, but the impelling force can be increased indefinitely. Each of these three possible solutions presents a different aspect of the main problem of increasing human energy, which is thus divided into three distinct problems, to be successively considered.

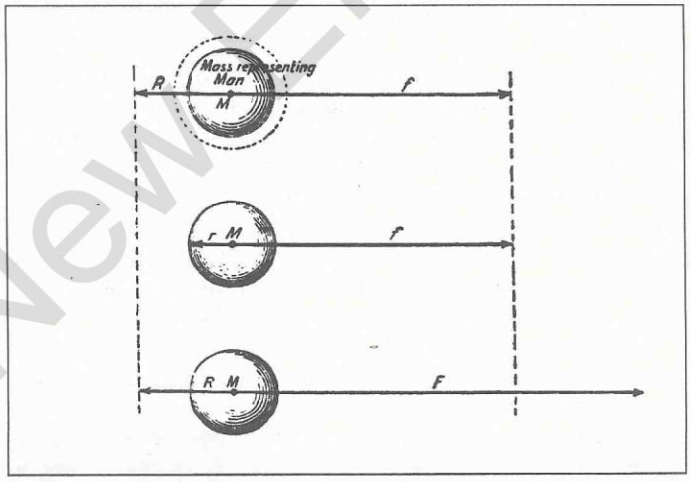

Diagram A. The three ways of increasing human energy.

The First Problem: How to Increase the Human Mass—The Burning of Atmospheric Nitrogen

Viewed generally, there are obviously two ways of increasing the mass of mankind: first, by aiding and maintaining those forces and conditions which tend to increase it; and, second, by opposing and reducing those which tend to diminish it. The mass will be increased by careful attention to health, by substantial food, by moderation, by regularity of habits, by promotion of marriage, by conscientious attention to children, and, generally stated, by the observance of all the many precepts and laws of religion and hygiene. But in adding new mass to the old, three cases again present themselves. Either the mass added is of the same velocity as the old, or it is of a smaller or of a higher velocity. To gain an idea of the relative importance of these cases, imagine a train composed of, say, one hundred locomotives running on a track, and suppose that, to increase the energy of the moving mass, four more locomotives are added to the train. If these four move at the same velocity at which the train is going, the total energy will be increased four percent; if they are moving at only one half of that velocity, the increase will amount to only one percent; if they are moving at twice that velocity, the increase of energy will be sixteen percent. This simple illustration shows that it is of greatest importance to add mass of a higher velocity. Stated more to the point, if, for example, the children be of the same degree of enlightenment as the parents,—that is, mass of the "same velocity,"—the energy will simply increase proportionately to the number added. If they are less intelligent or advanced, or mass of "smaller velocity," there will be a very slight gain in the energy; but if they are further advanced, or mass of "higher velocity," then the new generation will add very considerably to the sum total of human energy. Any addition of mass of "smaller velocity," beyond that indispensable amount required by the law expressed in the proverb, "Mens sana in corpore sano," should be strenuously opposed. For instance, the mere development of muscle, as aimed at in some of our colleges, I consider equivalent to adding mass of "smaller velocity," and I would not commend it, although my views were different when I was a student myself. Moderate exercise, insuring the right balance

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between mind and body, and the highest efficiency of performance, is, of course, a prime requirement. The above example shows that the most important result to be attained is the education, or the increase of the "velocity," of the mass newly added.

Conversely, it scarcely need be stated that everything that is against the teachings of religion *[And yet today, as in Tesla's time and long before, some religious dogmas and distortions encouraged murder of others not of the "true faith" or religious regimen. Tesla seemed to have a blind spot in this area.—EFM]* and the laws of hygiene is tending to decrease the mass. Whisky, wine, tea, coffee, tobacco, and other such stimulants are responsible for the shortening of the lives of many, and ought to be used with moderation. *[This just in: In 2003 we have learned from published studies that moderate use, of wine at least, and perhaps whiskey in moderation too, can be of great benefit to health.—EFM]* But I do not think that rigorous measures of suppression of habits followed through many generations are commendable. It is wiser to preach moderation than abstinence. We have become accustomed to these stimulants, and if such reforms are to be effected, they must be slow and gradual. Those who are devoting their energies to such ends could make themselves far more useful by turning their efforts in other directions, as, for instance, toward providing pure water. *[Pure water—indeed, still a compelling need worldwide in 2003, and making it abundant is intimately linked to the widespread availability of new, compact sources of energy.—EFM]* For every person who perishes from the effects of a stimulant, at least a thousand die from the consequences of drinking impure water. This precious fluid, which daily infuses new life into us, is likewise the chief vehicle through which disease and death enter our bodies. The germs of destruction it conveys are enemies all the more terrible as they perform their fatal work unperceived. They seal our doom while we live and enjoy. The majority of people are so ignorant or careless in drinking water, and the consequences of this are so disastrous, that a philanthropist can scarcely use his efforts better than by endeavoring to enlighten those who are thus injuring themselves. By systematic purification and sterilization of the drinking water the human mass would be very considerably increased. It should be made a rigid rule—which might be enforced by law—to boil or to sterilize otherwise the drinking water in every household and public place. The mere filtering does not afford sufficient security against infection. All ice for internal uses should be artificially prepared from water thoroughly sterilized. The importance of eliminating germs of disease from the city water is generally recognized, but little is being done to improve the existing conditions, as no satisfactory method of sterilizing great quantities of water has yet been brought forward. By improved electrical appliances we are now enabled to produce ozone cheaply and in large amounts, and this ideal disinfectant seems to offer a happy solution of the important question.

Gambling, business rush, and excitement, particularly on the exchanges, are causes of much mass reduction, all the more so because the individuals concerned represent units of higher value. Incapacity of observing the first symptoms of an illness, and careless neglect of the same, are important factors of mortality. In noting carefully every new sign of approaching danger, and making conscientiously every possible effort to avert it, we are not only following wise laws of hygiene in the interest of our well-being and the success of our labors, but we are also complying with a higher moral duty. Everyone should consider his body as a priceless gift from one whom he loves above all, as a marvelous work of art, of indescribable beauty and mastery beyond human conception, and so delicate and frail that a word, a breath, a look, nay, a thought, may injure it. Uncleanliness, which breeds disease and death, is not only a self-destructive but highly immoral habit. In keeping our bodies free from infection, healthful, and pure, we are expressing our reverence for the high principle with which they are endowed. He who follows the precepts of hygiene in this spirit is proving himself, so far, truly religious. Laxity of morals is a terrible evil, which poisons both mind and body, and which is responsible for a great reduction of the human mass in some countries. Many of the present customs and tendencies are productive of similar hurtful results. For example, the society life, modern education and pursuits of women, tending to draw them away from their household duties and make men out of them, must needs detract from the elevating ideal they represent, diminish the artistic creative power, and cause sterility and a general weakening of the race. *[Amazing! Tesla was putting himself firmly in the camp of those who would be called anti-feminists today—yet he spoke of the "elevating ideal they (women) represent."—EFM]* A thousand other evils might be mentioned, but all put together, in their bearing upon the problem under discussion, they could not equal a single one, the want of food, brought on by poverty, destitution, and famine. Millions of individuals die yearly for want of food, thus keeping down the mass. Even in our enlightened communities, and not withstanding the many charitable efforts, this is still, in all probability, the chief evil. I do not mean here absolute want of food, but want of healthful nutriment.

How to provide good and plentiful food is, therefore, a most important question of the day. On the general principles the raising of cattle as a means of providing food is objectionable, because, in the sense interpreted above, it must undoubtedly tend to the addition of mass of a "smaller velocity." It is certainly preferable to raise vegetables, and I think, therefore, that vegetarianism is a commendable departure from the established barbarous habit. That we can subsist on plant food and perform our work even to advantage is not a theory, but a well-demonstrated fact. Many races living almost exclusively on vegetables are of superior physique and strength. There is no doubt that some plant food, such as oatmeal, is more economical than meat, and superior to it in regard to both mechanical and mental performance. Such food, moreover, taxes our digestive organs decidedly less, and, in making us more contented and sociable, produces an amount of good difficult to estimate. In view of these facts every effort should be made to stop the wanton and cruel slaughter of animals, which must be destructive to our morals. To free ourselves from animal instincts and appetites, which keep us down, we should begin at the very root from which we spring: we should effect a radical reform in the character of the food.

There seems to be no *philosophical* necessity for food. We can conceive of organized beings living without nourishment, and deriving all the energy they need for the performance of their life functions from the ambient medium. *[Here Tesla makes an intuitive leap—that environmental energy (aether energy?) could, in principle, be made to sustain human life in lieu of energy-produc-*

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ing ingestible food!—EFM] In a crystal we have the clear evidence of the existence of a formative life-principle, and though we cannot understand the life of a crystal, it is none the less a living being. There may be, besides crystals, other such individualized, material systems of beings, perhaps of gaseous constitution *[The idea behind the late Sir Fred Hoyle's The Black Cloud science fiction novel—many decades before Hoyle conceived gaseous, plasmatic interstellar beings!—EFM],* or composed of substance still more tenuous. *[Aetheric "ghosts" perhaps, was he suggesting?—EFM]* In view of this possibility—nay, probability—we cannot apodictically deny the existence of organized beings on a planet merely because the conditions on the same are unsuitable for the existence of life as we conceive it. We cannot even, with positive assurance, assert that some of them might not be present here, in this our world, in the very midst of us, for their constitution and life-manifestation may be such that we are unable to perceive them. *[Here Tesla suggests what many non-mechanistic thinkers have been toying with. If the "vacuum" is not what modern science thinks it is, i.e. a plenum of "nothingness" infused with a random quantum-mechanical "foam," what may lurk in this realm that would astound us?—EFM]*

The production of artificial food as a means for causing an increase of the human mass naturally suggests itself, but a direct attempt of this kind to provide nourishment does not appear to me rational, at least not for the present. Whether we could thrive on such food is very doubtful. We are the result of ages of continuous adaptation, and we cannot radically change without unforeseen and, in all probability, disastrous consequences. So uncertain an experiment should not be tried. By far the best way, it seems to me, to meet the ravages of the evil, would be to find ways of increasing the productivity of the soil. With this object the preservation of forests is of an importance which cannot be overestimated, and in this connection, also, the utilization of water-power for purposes of electrical transmission, dispensing in many ways with the necessity of burning wood, and tending thereby to forest preservation, is to be strongly advocated. But there are limits in the improvement to be effected in this and similar ways.

To increase materially the productivity of the soil, it must be more effectively fertilized by artificial means. The question of food-production resolves itself, then, into the question how best to fertilize the soil. What it is that made the soil is still a mystery. To explain its origin is probably equivalent to explaining the origin of life itself. The rocks, disintegrated by moisture and heat and wind and weather, were in themselves not capable of maintaining life. Some unexplained condition arose, and some new principle came into effect, and the first layer capable of sustaining low organisms, like mosses was formed. These, by their life and death, added more of the life sustaining quality to the soil, and higher organisms could then subsist, and so on and on, until at last highly developed plant and animal life could flourish. But though the theories are, even now, not in agreement as to how fertilization is effected, it is a fact, only too well ascertained, that the soil cannot indefinitely sustain life, and some way must be found to supply it with the substances which have been abstracted from it by the plants. The chief and most valuable among these substances are compounds of nitrogen, and the cheap production of these is, therefore, the key for the solution of the all-important food problem. Our atmosphere contains an inexhaustible amount of nitrogen, and could we but oxidize it and produce these compounds, an incalculable benefit for mankind would follow.

Long ago this idea took a powerful hold on the imagination of scientific men, but an efficient means for accomplishing this result could not be devised. The problem was rendered extremely difficult by the extraordinary inertness of the nitrogen, which refuses to combine even with oxygen. But here electricity comes to our aid: the dormant affinities of the element are awakened by an electric current of the proper quality. As a lump of coal which has been in contact with oxygen for centuries without burning will combine with it when once ignited, so nitrogen, excited by electricity, will burn. I did not succeed, however, in producing electrical discharges exciting very effectively the atmospheric nitrogen until a comparatively recent date, although I showed, in May, 1891, in a scientific lecture, a novel form of discharge or electrical flame named "St. Elmo's hotfire," which, besides being capable of generating ozone in abundance, also possessed, as I pointed out on that occasion, distinctly the quality of exciting chemical affinities. This discharge or flame was then only three or four inches long, its chemical action was likewise very feeble, and consequently the process of oxidation of nitrogen was wasteful. How to intensify this action was the question. Evidently electric currents of a peculiar kind had to be produced in order to render the process of nitrogen combustion more efficient.

The first advance was made in ascertaining that the chemical activity of the discharge was very considerably increased by using currents of extremely high frequency or rate of vibration. This was an important improvement, but practical considerations soon set a definite limit to the progress in this direction. Next, the effects of the electrical pressure of the current impulses, of their wave-form and other characteristic features, were investigated. Then the influence of the atmospheric pressure and temperature and of the presence of water and other bodies was studied, and thus the best conditions for causing the most intense chemical action of the discharge and securing the highest efficiency of the process were gradually ascertained. Naturally, the improvements were not quick in coming; still, little by little, I advanced. The flame grew larger and larger, and its oxidizing action grew more intense. From an insignificant brush-discharge a few inches long it developed into a marvelous electrical phenomenon, a roaring blaze, devouring the nitrogen of the atmosphere and measuring sixty or seventy feet across. Thus slowly, almost imperceptibly, possibility became accomplishment. All is not yet done, by any means, but to what a degree my efforts have been rewarded an idea may be gained from an inspection of Figure 1, which, with its title, is self-explanatory. The flame-like discharge visible is produced by the intense electrical oscillations which pass through the coil shown, and violently agitate the electrified molecules of the air. By this means a strong affinity is created between the two normally indifferent constituents of the atmosphere, and they combine readily, even if no further provision is made for intensifying the chemical action of the discharge. In the manufacture of nitrogen compounds by this method, of course, every possible means bearing upon the intensity of this action and the efficiency of the process will be taken advantage of, and, besides, special arrangements will be provided for the fixation of the compounds formed, as they are generally unstable, the nitrogen becoming again inert after a

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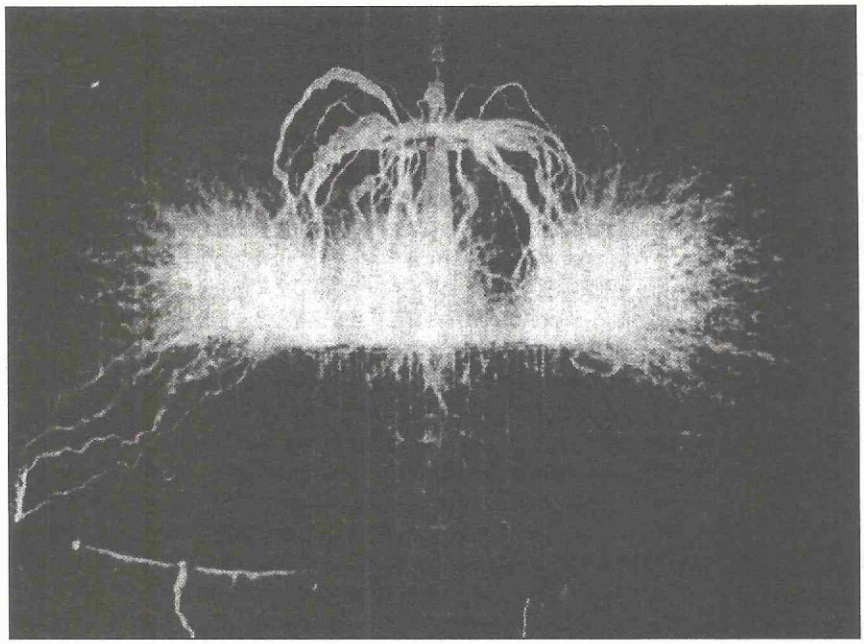

Figure 1. Burning the nitrogen of the atmosphere. This result is produced by the discharge of an electrical oscillator giving twelve million volts. The electrical pressure, alternating one hundred thousand times per second, excites the normally inert nitrogen, causing it to combine with the oxygen. The flame-like discharge shown in the photograph measures sixty-five feet across.

little lapse of time. Steam is a simple and effective means for fixing permanently the compounds. The result illustrated makes it practicable to oxidize the atmospheric nitrogen in unlimited quantities, merely by the use of cheap mechanical power and simple electrical apparatus. In this manner many compounds of nitrogen may be manufactured all over the world, at a small cost, and in any desired amount, and by means of these compounds the soil can be fertilized and its productiveness indefinitely increased. An abundance of cheap and healthful food, not artificial, but such as we are accustomed to, may thus be obtained. This new and inexhaustible source of food-supply will be of incalculable benefit to mankind, for it will enormously contribute to the increase of the human mass, and thus add immensely to human energy. Soon, I hope, the world will see the beginning of an industry which, in time to come, will, I believe, be in importance next to that if iron. *[Indeed, the production of fertilizers, facilitated by an abundance of New Energy, will help fulfill Tesla's dream of the great augmentation of worldwide agriculture.—EFM]*

The Second Problem: How to Reduce the Force Retarding the Human Mass—The Art of Telautomatics

As before stated, the force which retards the onward movement of man is partly frictional and partly negative. To illustrate this distinction I may name, for example, ignorance, stupidity, and imbecility as some of the purely frictional forces, or resistances devoid of any directive tendency. On the other hand, visionariness *[This is a peculiar item for a list of negatives! He seems to be saying that "visionariness"—being a visionary?—is not good? Perhaps in 1900 the word meant one who sees visions or hallucinates?—EFM]*, insanity, self-destructive tendency, religious fanaticism, and the like, are all forces of a negative character, acting in definite directions. To reduce or entirely overcome these dissimilar retarding forces, radically different methods must be employed. One knows, for instance, what a fanatic may do, and one can take preventive measures, can enlighten, convince, and, possibly direct him, turn his vice into virtue; but one does not know, and never can know, what a brute or an imbecile may do, and one must deal with him as with a mass, inert, without mind, let loose by the mad elements. A negative force always implies some quality, not infrequently a high one, though badly directed, which it is possible to turn to good advantage; but a directionless, frictional force involves unavoidable loss. Evidently, then, the first and general answer to the above question is: turn all negative force in the right direction and reduce all frictional force.

There can be no doubt that, of all the frictional resistances, the one that most retards human movement is ignorance. Not without reason said that man of wisdom, Buddha: "Ignorance is the greatest evil in the world." The friction which results from ignorance, and which is greatly increased owing to the numerous languages and nationalities, can be reduced only by the spread of knowledge and the unification of the heterogeneous elements of humanity. *[Ah, education and universal harmony therefrom among peoples, as a very high priority! In 2003, media saturation and the Internet have still not eliminated the world's disharmonies. The "education" that is today spread so easily often transmits erroneous or hateful ideas.—EFM]* No effort could be better spent. But however ignorance may have retarded the onward movement of man in times past, it is certain that, nowadays, negative forces have become of greater importance. Among these there is one of far greater moment than any other. It is called organized warfare. When we consider the millions of individuals, often the ablest in mind and body, the flower of humanity, who are compelled to a life of inactivity and unproductiveness, the immense sums of money daily required for the maintenance of armies and war apparatus, representing ever so much of human energy, all the effort uselessly spent in the production of arms and implements of destruction, the loss of life and the fostering of a barbarous spirit, we are appalled at the inestimable loss to mankind which the existence of these deplorable conditions must involve. *[An enlightened statement on the ultimate costs of warfare.—EFM]* What can we do to combat best this great evil?

Law and order absolutely require the maintenance of organized force. No community can exist and prosper without rigid discipline. Every country must be able to defend itself, should the necessity arise. The conditions of today are not the result of yesterday, and a radical change cannot be effected tomorrow. If the nations would at once disarm, it is more than likely that a state of things worse than war itself would follow. Universal peace is a beautiful dream, but not at once realizable. We have seen recently that even the nobel effort of the man invested with the greatest worldly power has been virtually without effect. And no wonder, for the establishment of universal peace is, for the time being, a physical impossibility. War is a negative force, and cannot be turned in

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a positive direction without passing through, the intermediate phases. It is a problem of making a wheel, rotating one way, turn in the opposite direction without slowing it down, stopping it, and speeding it up again the other way.

It has been argued that the perfection of guns of great destructive power will stop warfare. So I myself thought for a long time, but now I believe this to be a profound mistake. Such developments will greatly modify, but not arrest it. On the contrary, I think that every new arm that is invented, every new departure that is made in this direction, merely invites new talent and skill, engages new effort, offers new incentive, and so only gives a fresh impetus to further development. *[Tesla has thought deeply about the acceleration of war-related technologies. One wonders what he would have thought about the concept of weapons as powerful as nuclear weapons. Would he have thought that these "unthinkable" bombs would indefinitely deter war among all nations?—EFM]* Think of the discovery of gun-powder. Can we conceive of any more radical departure than was effected by this innovation? Let us imagine ourselves living in that period: would we not have thought then that warfare was at an end, when the armor of the knight became an object of ridicule, when bodily strength and skill, meaning so much before, became of comparatively little value? Yet gunpowder did not stop warfare: quite the opposite—it acted as a most powerful incentive. Nor do I believe that warfare can ever be arrested by any scientific or ideal development, so long as similar conditions to those prevailing now exist, because war has itself become a science, and because war involves some of the most sacred sentiments of which man is capable. In fact, it is doubtful whether men who would not be ready to fight for a high principle would be good for anything at all. It is not the mind which makes man, nor is it the body; it is mind and body. Our virtues and our failings are inseparable, like force and matter. When they separate, man is no more.

Another argument, which carries considerable force, is frequently made, namely, that war must soon become impossible because the means of defense are outstripping the means of attack. This is only in accordance with a fundamental law which may be expressed by the statement that it is easier to destroy than to build. This law defines human capacities and human conditions. Were these such that it would be easier build than to destroy, man would go on unresisted, creating and accumulating without limit. Such conditions are not of this Earth. A being which could do this would not be a man: it might be a god. Defense will always have the advantage over attack, but this alone, it seems to me, can never stop war. By the use of new principles of defense we can render harbors impregnable against attack, but we cannot by such means prevent two warships meeting in battle on the high sea. And then, if we follow this idea to its ultimate development, we are led to the conclusion that it would be better for mankind if attack and defense were just oppositely related; for if every country, even the smallest, could surround itself with a wall absolutely impenetrable, and could defy the rest of the world, a state of things would surely be brought on which would be extremely unfavorable to human progress. It is by abolishing all the barriers which separate nations and countries that civilization is best furthered.

Again, it is contended by some that the advent of the flying-machine must bring on universal peace. This, too, I believe to be an entirely erroneous view. The flying-machine is certainly coming, and very soon, but the conditions will remain the same as before. In fact, I see no reason why a ruling power, like Great Britain, might not govern the air as well as the sea. Without wishing to put myself on record as a prophet, I do not hesitate to say that the next years will see the establishment of an "air-power," and its center may be not far from New York. But, for all that, men will fight on merrily. *[The "flying machine" had not yet been brought forth—this was three years before the Wright brothers' success at Kitty Hawk. But Tesla thinks it is an inevitable invention that will soon come—contrary to some scientific negativists of his day. He foresees a new era of air warfare.—EFM]*

The ideal development of the war principle would ultimately lead to the transformation of the whole energy of war into purely potential, explosive energy, like that of an electrical condenser. In this form the war-energy could be maintained without effort; it would need to be much smaller in amount, while incomparably more effective. *[This seems to foreshadow something like nuclear weapons.—EFM]*

As regards the security of a country against foreign invasion, it is interesting to note that it depends only on the relative, and not the absolute, number of the individuals or magnitude of the forces, and that, if every country should reduce the war-force in the same ratio, the security would remain unaltered. An international agreement with the object of reducing to a minimum the war-force which, in view of the present still imperfect education of the masses, is absolutely indispensable, would, therefore, seem to be the first rational step to take toward diminishing the force retarding human movement.

Fortunately, the existing conditions cannot continue indefinitely, for a new element is beginning to assert itself. A change for the better is eminent and I shall now endeavor to show what, according to my ideas, will be the first advance toward the establishment of peaceful relations between nations, and by what means it will eventually be accomplished.

Let us go back to the early beginning, when the law of the stronger was the only law. The light of reason was not yet kindled, and the weak was entirely at the mercy of the strong. The weak individual then began to learn how to defend himself. He made use of a club, stone, spear, sling, or bow and arrow, and in the course of time, instead of physical strength, intelligence became the chief deciding factor in the battle. The wild character was gradually softened by the awakening of noble sentiments, and so, imperceptibly, after ages of continued progress, we have come from the brutal fight of the unreasoning animal to what we call the "civilized warfare" of today, in which the combatants shake hands, talk in a friendly way, and smoke cigars in the entr'actes, ready to engage again in deadly conflict at a signal. Let pessimists say what they like, here is an absolute evidence of great and gratifying advance. *[Apparently Tesla thought that the evolution of "gentlemanly conduct" in war had made war "better." In any case, twentieth century warfare was to be anything but "gentlemanly."—EFM]*

But now, what is the next phase in this evolution? Not peace as yet, by any means. The next change which should naturally follow from modern developments should be the continuous diminution of the number of individuals engaged in battle. The apparatus will be one of specifically great power, but only a few individuals will be required to operate it. This evolution will bring more and more into

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prominence a machine or mechanism with the fewest individuals as an element of warfare, and the absolutely unavoidable consequence of this will be the abandonment of large, clumsy, slowly moving, and unmanageable units. Greatest possible speed and maximum rate of energy-delivery by the war apparatus will be the main object. The loss of life will become smaller and smaller, and finally, the number of the individuals continuously diminishing, merely machines will meet in a contest without blood-shed, the nations being simply interested, ambitious spectators. *[This prediction most certainly did NOT come about!—EFM]* When this happy condition is realized, peace will be assured. But, no matter to what degree of perfection rapid-fire guns, high-power cannon, explosive projectiles, torpedo-boats, or other implements of war may be brought, no matter how destructive they may be made, that condition can never be reached through any such development. All such implements require men for their operation; men are indispensable parts of the machinery. Their object is to kill and to destroy. Their power resides in their capacity for doing evil. So long as men meet in battle, there will be bloodshed. Bloodshed will ever keep up barbarous passion. To break this fierce spirit, a radical departure must be made, an entirely new principle must be introduced, something that never existed before in warfare—a principle which will forcibly, unavoidably, turn the battle into a mere spectacle, a play, a contest without loss of blood. To bring on this result men must be dispensed with: machine must fight machine. But how accomplish that which seems impossible? The answer is simple enough: produce a machine capable of acting as though it were part of a human being—no mere mechanical contrivance, comprising levers, screws, wheels, clutches, and nothing more, but a machine embodying a higher principle, which will enable it to per form its duties as though it had intelligence, experience, judgment, a mind! *[Tesla envisions robotic warfare, but he fails to project that robots ("smart weapons" in today's parlance) would still be used against other people— there would be no switch to contests of robots!—EFM]* This conclusion is the result of my thoughts and observations which have extended through virtually my whole life, and I shall now briefly describe how I came to accomplish that which at first seemed an unrealizable dream.

A long time ago, when I was a boy, I was afflicted with a singular trouble, which seems to have been due to an extraordinary excitability of the retina. It was the appearance of images which, by their persistence, marred the vision of real objects and interfered with thought. When a word was said to me, the image of the object which it designated would appear vividly before my eyes, and many times it was impossible for me to tell whether the object I saw was real or not. *[This description of Tesla's condition of instant visualization is remarkable; it gives insight into the nature of his genius, which almost seemed to have aspects of a neurological malady.—EFM]* This caused me great discomfort and anxiety, and I tried hard to free myself of the spell. But for a long time I tried in vain, and it was not, as I clearly recollect, until I was about twelve years old that I succeeded for the first time, by an effort of the will, in banishing an image which presented itself. My happiness will never be as complete as it was then, but, unfortunately (as I thought at that time), the old trouble returned, and with it my anxiety. Here it was that the observations to which I refer began. I noted, namely, that whenever the image of an object appeared before my eyes I had seen something that reminded me of it. In the first instances I thought this to be purely accidental, but soon I convinced myself that it was not so. A visual impression, consciously or unconsciously received, invariably preceded the appearance of the image. Gradually the desire arose in me to find out, every time, what caused the images to appear, and the satisfaction of this desire soon became a necessity. The next observation I made was that, just as these images followed as a result of something I had seen, so also the thoughts which I conceived were suggested in like manner. Again, I experienced the same desire to locate the image which caused the thought, and this search for the original visual impression soon grew to be a second nature. My mind became automatic, as it were, and in the course of years of continued, almost unconscious performance, I acquired the ability of locating every time and, as a rule, instantly the visual impression which started the thought. Nor is this all. It was not long before I was aware that also all my movements were prompted in the same way, and so, searching, observing, and verifying continuously, year by year, I have, by every thought and every act of mine, demonstrated, and do so daily, to my absolute satisfaction, that I am an automaton endowed with power of movement, which merely responds to external stimuli beating upon my sense organs, and thinks and acts and moves accordingly. I remember only one or two cases in all my life in which I was unable to locate the first impression which prompted a movement or a thought, or even a dream. *[The foregoing is an astonishing description of an inner psychological life, which, in its own way, must have been excruciating to Tesla.—EFM]*

With these experiences it was only natural that, long ago, I conceived the idea of constructing an automaton which would mechanically represent me, and which would respond, as I do myself, but, of course, in a much more primitive manner, to external influences. Such an automaton evidently had to have motive power, organs for locomotion, directive organs, and one or more sensitive organs so adapted as to be excited by external stimuli. This machine would, I reasoned, perform its movements in the manner of a living being, for it would have all the chief mechanical characteristics or elements of the same. There was still the capacity for growth, propagation, and, above all, the mind which would be wanting to make the model complete. But growth was not necessary in this case, since a machine could be manufactured full grown, so to speak. As to the capacity for propagation, it could likewise be left out of consideration, for in the mechanical model it merely signified a process of manufacture. Whether the automaton be of flesh and bone, or of wood and steel, it mattered little, provided it could perform all the duties required of it like an intelligent being. To do so, it had to have an element corresponding to the mind, which would effect the control of all its movements and operations, and cause it to act, in any unforeseen case that might present itself, with knowledge, reason, judgment, and experience. But this element I could easily embody in it by conveying to it my own intelligence, my own understanding. So this invention was evolved, and so a new art came into existence, for which the name "telautomatics" has been suggested, which means the art of controlling the movements and operations of distant automatons. This principle evidently was applicable to any kind of machine that moves on

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land or in the water or in the air. In applying it practically for the first time, I selected a boat (see Figure 2). A storage battery placed within it furnished the motive power. The propeller, driven by a motor, represented the locomotive organs. The rudder, controlled by another motor likewise driven by the battery, took the place of the directive organs. As to the sensitive organ, obviously the first thought was to utilize a device responsive to rays of light, like a selenium cell, to represent the human eye. But upon closer inquiry I found that, owing to experimental and other difficulties, no thoroughly satisfactory control of the automaton could be effected by light, radiant heat, hertzian radiations, or by rays in general, that is, disturbances which pass in straight lines through space. One of the reasons was that any obstacle coming between the operator and the distant automaton would place it beyond his control. Another reason was that the sensitive device representing the eye would have to be in a definite position with respect to the distant controlling apparatus, and this necessity would impose great limitations in the control. Still another and very important reason was that, in using rays, it would be difficult, if not impossible, to give to the automaton individual features or characteristics distinguishing it from other machines of this kind. Evidently the automaton should respond only to an individual call, as a person responds to a name. Such considerations led me to conclude that the sensitive device of the machine should correspond to the ear rather than the eye of a human being, for in this case its actions could be controlled irrespective of intervening obstacles, regardless of its position relative to the distant controlling apparatus, and, last, but not least, it would remain deaf and unresponsive, like a faithful servant, to all calls but that of its master. These requirements made it imperative to use, in the control of the automaton, instead of light or other rays, waves or disturbances which propagate in all directions through space, like sound, or which follow a path of least resistance, however curved. I attained the result aimed at by means of an electric circuit placed within the boat, and adjusted, or "tuned," exactly to electrical vibrations of the proper kind transmitted to it from a distant "electrical oscillator." This circuit, in responding, however feebly, to the transmitted vibrations, affected magnets and other contrivances, through the medium of which were controlled the movements of the propeller and rudder, and also the operations of numerous other appliances.

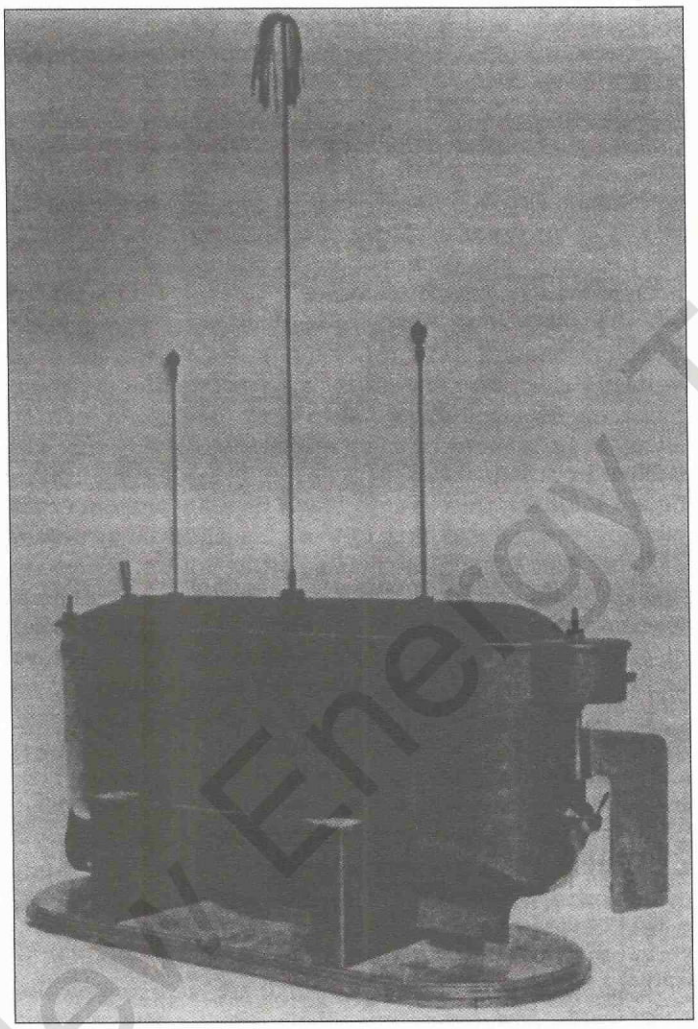

Figure 2. The first practical telautomaton. A machine having all the bodily or translatory movements and the operations of the interior mechanism controlled from a distance without wires. The crewless boat shown in the photograph contains its own motive power, propelling and steering machinery, and numerous other accessories, all of which are controlled by transmitting from a distance, without wires, electrical oscillations to a circuit carried by the boat and adjusted to respond only to these oscillations.

By the simple means described the knowledge, experience, judgment—the mind, so to speak—of the distant operator were embodied in that machine, which was thus enabled to move and to perform all its operations with reason and intelligence. It behaved just like a blindfolded person obeying directions received through the ear.

The automatons so far constructed had "borrowed minds," so to speak, as each merely formed part of the distant operator who conveyed to it his intelligent orders; but this art is only in the beginning. I purpose to show that, however impossible it may now seem, an automaton may be contrived which will have its "own mind," and by this I mean that it will be able, independent of any operator, left entirely to itself, to perform, in response to external influences affecting its sensitive organs, a great variety of acts and operations as if it had intelligence. It will be able to follow a course laid out or to obey orders given far in advance; it will be capable of distinguishing between what it ought and what it ought not to do, and of making experiences or, otherwise stated, of recording impressions which will definitely affect its subsequent actions. In fact, I have already conceived such a plan. *[Tesla has described the general outlines of today's field of artificial intelligence.—EFM]*

Although I evolved this invention many years ago and explained it to my visitors very frequently in my laboratory demonstrations, it was not until much later, long after I had perfected it, that it became known, when, naturally enough, it gave rise to much discussion and to sensational reports. But the true significance of this new art was not grasped by the majority, nor was the great force of the underlying principle recognized. As nearly as I could judge from the numerous comments which appeared, the results I had obtained were considered as entirely impossible. Even the few who were disposed to admit the practicability of the invention saw in it merely an automobile torpedo, which was to be used for the purpose of blowing up battleships, with doubt-

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ful success. The general impression was that I contemplated simply the steering of such a vessel by means of Hertzian or other rays. There are torpedoes steered electrically by wires, and there are means of communicating without wires, and the above was, of course an obvious inference. Had I accomplished nothing more than this, I should have made a small advance indeed. But the art I have evolved does not contemplate merely the change of direction of a moving vessel; it affords means of absolutely controlling, in every respect, all the innumerable translatory movements, as well as the operations of all the internal organs, no matter how many, of an individualized automaton. Criticisms to the effect that the control of the automaton could be interfered with were made by people who do not even dream of the wonderful results which can be accomplished by use of electrical vibrations. The world moves slowly, and new truths are difficult to see. Certainly, by the use of this principle, an arm for attack as well as defense may be provided, of a destructiveness all the greater as the principle is applicable to submarine and aerial vessels. There is virtually no restriction as to the amount of explosive it can carry, or as to the distance at which it can strike, and failure is almost impossible. But the force of this new principle does not wholly reside in its destructiveness. Its advent introduces into warfare an element which never existed before—a fighting-machine without men as a means of attack and defense. The continuous development in this direction must ultimately make war a mere contest of machines without men and without loss of life—a condition which would have been impossible without this new departure, and which, in my opinion, must be reached as preliminary to permanent peace. The future will either bear out or disprove these views. My ideas on this subject have been put forth with deep conviction, but in a humble spirit. *[It transpired that Tesla was both right and wrong. The devastating technology he envisioned, akin to the terminal guidance phase of some intercontinental ballistic missiles with nuclear weapons, indeed has deterred wars. But robots with lesser explosive power than nuclear weapons have facilitated warfare—made it easier and more "antiseptic."—EFM]*

The establishment of permanent peaceful relations between nations would most effectively reduce the force retarding the human mass, and would be the best solution of this great human problem. But will the dream of universal peace ever be realized? Let us hope that it will. When all darkness shall be dissipated by the light of science, when all nations shall be merged into one, and patriotism shall be identical with religion, when there shall be one language, one country, one end, then the dream will have become reality. *[Over a century later, Tesla's dream seems as far off as ever.—EFM]*

The Third Problem: How to Increase the Force Accelerating the Human Mass—The Harnessing of the Sun's Energy

Of the three possible solutions of the main problem of increasing human energy, this is by far the most important to consider, not only because of its intrinsic significance, but also because of its intimate bearing on all the many elements and conditions which determine the movement of humanity. In order to proceed systematically, it would be necessary for me to dwell on all those considerations which have guided me from the outset in my efforts to arrive at a solution, and which have led me, step by step, to the results I shall now describe. As a preliminary study of the problem an analytical investigation, such as I have made, of the chief forces which determine the onward movement, would be of advantage, particularly in conveying an idea of that hypothetical "velocity" which, as explained in the beginning, is a measure of human energy; but to deal with this specifically here, as I would desire, would lead me far beyond the scope of the present subject. Suffice it to state that the resultant of all these forces is always in the direction of reason, which therefore, determines, at any time, the direction of human movement. This is to say that every effort which is scientifically applied, rational, useful, or practical, must be in the direction in which the mass is moving. The practical, rational man, the observer, the man of business, he who reasons, calculates, or determines in advance, carefully applies his effort so that when coming into effect it will be in the direction of the movement, making it thus most efficient, and in this knowledge and ability lies the secret of his success. Every new fact discovered, every new experience or new element added to our knowledge and entering into the domain of reason, affects the same and, therefore, changes the direction of movement, which, however, must always take place along the resultant of all those efforts which, at that time, we designate as reasonable, that is, self-preserving, useful, profitable, or practical. These efforts concern our daily life, our necessities and comforts, our work and business, and it is these which drive man onward.

But looking at all this busy world about us, on all this complex mass as it daily throbs and moves, what is it but an immense clock-work driven by a spring? In the morning, when we rise, we cannot fail to note that all the objects about us are manufactured by machinery: the water we use is lifted by steam-power; the trains bring our breakfast from distant localities; the elevators in our dwelling and our office building, the cars that carry us there, are all driven by power; in all our daily errands, and in our very life-pursuit, we depend upon it; all the objects we see tell us of it; and when we return to our machine-made dwelling at night, lest we should forget it, all the material comforts of our home, our cheering stove and lamp, remind us of how much we depend on power. And when there is an accidental stoppage of the machinery, when the city is snowbound, or the life sustaining movement otherwise temporarily arrested, we are affrighted to realize how impossible it would be for us to live the life we live without motive power. Motive power means work. To increase the force accelerating human movement means, therefore, to perform more work. *[Tesla identifies energy (work) as the central commodity that drives civilization.—EFM]*

So we find that the three possible solutions of the great problem of increasing human energy are answered by the three words: *food, peace, work*. Many a year I have thought and pondered, lost myself in speculations and theories, considering man as a mass moved by a force, viewing his inexplicable movement in the light of a mechanical one, and applying the simple principles of mechanics to the analysis of the same until I arrived at these solutions, only to realize that they were taught to me in my early childhood. These three words sound the key-notes of the Christian religion. Their scientific meaning and purpose now clear to me: food to increase the mass, peace to diminish the retarding force,

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and work to increase the force accelerating human movement. These are the only three solutions which are possible of that great problem, and all of them have one object, one end, namely, to increase human energy. When we recognize this, we cannot help wondering how profoundly wise and scientific and how immensely practical the Christian religion is, and in what a marked contrast it stands in this respect to other religions. *[Quite a disappointing revelation, to find that Tesla thinks of only one religion—namely **his**—as being superior to all others!—EFM]* It is unmistakably the result of practical experiment and scientific observation which have extended through the ages, while other religions seem to be the outcome of merely abstract reasoning. Work, untiring effort, useful and accumulative, with periods of rest and recuperation aiming at higher efficiency, is its chief and ever-recurring command. Thus we are inspired both by Christianity and Science to do our utmost toward increasing the performance of mankind. This most important of human problems I shall now specifically consider.

The Source of Human Energy: The Three Ways of Drawing Energy from the Sun

First let us ask: Whence comes all the motive power? What is the spring that drives all? We see the ocean rise and fall, the rivers flow, the wind, rain, hail, and snow beat on our windows, the trains and steamers come and go; we here the rattling noise of carriages, the voices from the street; we feel, smell, and taste; and we think of all this. And all this movement, from the surging of the mighty ocean to that subtle movement concerned in our thought, has but one common cause. All this energy emanates from one single center, one single source—the Sun. The Sun is the spring that drives all. The Sun maintains all human life and supplies all human energy. Another answer we have now found to the above great question: To increase the force accelerating human movement means to turn to the uses of man more of the Sun's energy. We honor and revere those great men of bygone times whose names are linked with immortal achievements, who have proved themselves benefactors of humanity—the religious reformer with his wise maxims of life, the philosopher with his deep truths, the mathematician with his formula, the physicist with his laws, the discoverer with his principles and secrets wrested from nature, the artist with his forms of the beautiful; but who honors him, the greatest of all—who can tell the name of him—who first turned to use the Sun's energy to save the effort of a weak fellow-creature? That was man's first act of scientific philanthropy, and its consequences have been incalculable. *[An "act of scientific philanthropy"—a very imaginative conception and phrase. In another context, in another age (2003), let us have **philanthropy for science**, to further Tesla's work!—EFM]*

From the very beginning three ways of drawing energy from the Sun were open to man. The savage, when he warmed his frozen limbs at a fire kindled in some way, availed himself of the energy of the Sun stored in the burning material. When he carried a bundle of branches to his cave and burned them there, he made use of the Sun's stored energy transported from one to another locality. When he set sail to his canoe, he utilized the energy of the Sun applied to the atmosphere or the ambient medium. There can be no doubt that the first is the oldest way. A fire, found accidentally, taught the savage to appreciate its beneficial heat. He then very likely conceived of the idea of carrying the glowing members to his abode. Finally he learned to use the force of a swift current of water or air. It is characteristic of modern development that progress has been effected in the same order. The utilization of the energy stored in wood or coal, or, generally speaking, fuel, led to the steam-engine. Next a great stride in advance was made in energy-transportation by the use of electricity, which permitted the transfer of energy from one locality to another without transporting the material. But as to the utilization of the energy of the ambient medium, no radical step forward has as yet been made known. *[Here Tesla enunciates what may be the first reference in modern times to the concept of "free energy"—using the "energy of the ambient medium." He says "**no radical step** has been made known."—EFM]*

The ultimate results of development in these three directions are: first, the burning of coal by a cold process in a battery; second, the efficient utilization of the energy of the ambient medium; and, third the transmission without wires of electrical energy to any distance. In whatever way these results may be arrived at, their practical application will necessarily involve an extensive use of iron, and this invaluable metal will undoubtedly be an essential element in the further development along these three lines. If we succeed in burning coal by a cold process *[Tesla suggests a process which is in relation to high-temperature combustion as radical—in the nuclear arena—as cold fusion would later be to hot fusion.—EFM]* and thus obtain electrical energy in an efficient and inexpensive manner, we shall require in many practical uses of this energy electric motors—that is, iron. If we are successful in deriving energy from the ambient medium, we shall need, both in the obtainment and utilization of the energy, machinery—again, iron. If we realize the transmission of electrical energy without wires on an industrial scale, we shall be compelled to use extensively electric generators—once more, iron. Whatever we may do, iron will probably be the chief means of accomplishment in the near future, possibly more so than in the past. How long its reign will last is difficult to tell, for even now aluminium is looming up as a threatening competitor. But for the time being, next to providing new resources of energy, it is of the greatest importance to making improvements in the manufacture and utilization of iron. Great advances are possible in these latter directions, which, if brought about, would enormously increase the useful performance of mankind.

Great Possibilities Offered by Iron for Increasing Human Performance—Enormous Waste in Iron Manufacture

Iron is by far the most important factor in modern progress. It contributes more than any other industrial product to the force accelerating human movement. So general is the use of this metal, and so intimately is it connected with all that concerns our life, that it has become as indispensable to us as the very air we breathe. Its name is synonymous with usefulness. But, however great the influence of iron may be on the present human development, it does not add to the force urging man onward nearly as much as it might. First of all, its manufacture as now carried on is connected with an

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appalling waste of fuel—that is, waste of energy. Then, again, only a part of all the iron produced is applied for useful purposes. A good part of it goes to create frictional resistances, while still another large part is the means of developing negative forces greatly retarding human movement. Thus the negative force of war is almost wholly represented in iron. It is impossible to estimate with any degree of accuracy the magnitude of this greatest of all retarding forces, but it is certainly very considerable. If the present positive impelling force due to all useful applications of iron be represented by ten, for instance, I should not think it exaggeration to estimate the negative force of war, with due consideration of all its retarding influences and results, at, say, six. On the basis of this estimate the effective impelling force of iron in the positive direction would be measured by the difference of these two numbers, which is four. But if, through the establishment of universal peace, the manufacture of war machinery should cease, and all struggle for supremacy between nations should be turned into healthful, ever active and productive commercial competition, then the positive impelling force due to iron would be measured by the sum of those two, numbers, which is sixteen—that is, this force would have four times its present value. This example is, of course, merely intended to give an idea of the immense increase in the useful performance of mankind which would result from a radical reform of the iron industries supplying the implements of warfare.

A similar inestimable advantage in the saving of energy available to man would be secured by obviating the great waste of coal which is inseparably connected with the present methods of manufacturing iron. In some countries, such as Great Britain, the hurtful effects of this squandering of fuel are beginning to be felt. The price of coal is constantly rising, and the poor are made to suffer more and more. Though we are still far from the dreaded "exhaustion of the coal-fields," philanthropy commands us to invent novel methods of manufacturing iron, which will not involve such barbarous waste of this valuable material from which we derive at present most of our energy. It is our duty to coming generations to leave this store of energy intact for them, or at least not to touch it until we shall have perfected processes for burning coal more efficiently. Those who are coming after us will need fuel more than we do. We should be able to manufacture the iron we require by using the Sun's energy, without wasting any coal at all. As an effort to this end the idea of smelting iron ores by electric currents obtained from the energy of falling water has naturally suggested itself to many. I have myself spent much time in endeavoring to evolve such a practical process, which would enable iron to be manufactured at small cost. After a prolonged investigation of the subject, finding that it was unprofitable to use the currents generated directly for smelting the ore, I devised a method which is far more economical.

Economical Production of Iron by a New Process

The industrial project, as I worked it out six years ago, contemplated the employment of the electric currents derived from the energy of a waterfall, not directly for smelting the ore, but for decomposing water for a preliminary step. *[Tesla here is envisioning what would later be called the "hydrogen economy."—EFM]* To lessen the cost of the plant, I proposed to generate the currents in exceptionally cheap and simple dynamos, which I designed for this sole purpose. The hydrogen liberated in the electrolytic decomposition was to be burned or recombined with oxygen, not with that from which it was separated, but with that of the atmosphere. Thus very nearly the total electrical energy used up in the decomposition of the water would be recovered in the form of heat resulting from the recombination of the hydrogen. This heat was to be applied to the smelting of ore. The oxygen gained as a by-product of the decomposition of the water I intended to use for certain other industrial purposes, which would probably yield good financial returns, inasmuch as this is the cheapest way of obtaining this gas in large quantities. In any event, it could be employed to burn all kinds of refuse, cheap hydrocarbon, or coal of the most inferior quality which could not be burned in air or be otherwise utilized to advantage, and thus again a considerable amount of heat would be made available for the smelting of the ore. To increase the economy of the process I contemplated, furthermore, using an arrangement such that the hot metal and the products of combustion, coming out of the furnace, would give up their heat upon the cold ore going into the furnace, so that comparatively little of the heat energy would be lost in the smelting. I calculated that probably forty thousand pounds of iron could be produced per horse-power per annum by this method. Liberal allowances were made for those losses which are unavoidable, the above quantity being about half of that theoretically obtainable. Relying on this estimate and on practical data with reference to a certain kind of sand ore existing in abundance in the region of the Great Lakes, including cost of transportation and labor, I found that in some localities iron could be manufactured in this manner cheaper than by any of the adopted methods. This result would be obtained all the more surely if the oxygen obtained from the water, instead of being used for smelting of ore, as assumed, should be more profitably employed. Any new demand for this gas would secure a higher revenue from the plant, thus cheapening the iron. This project was advanced merely in the interest of industry. Some day, I hope, a beautiful industrial butterfly will come out of the dusty and shriveled chrysalis.

The production of iron from sand ores by a process of magnetic separation is highly commendable in principle, since it involves no waste of coal; but the usefulness of this method is largely reduced by the necessity of melting the iron afterward. As to the crushing of iron ore, I would consider it rational only if done by water-power, or by energy otherwise obtained without consumption of fuel. An electrolytic cold process, which would make it possible to extract iron cheaply, and also to mold it into the required forms without any fuel consumption, would, in my opinion, be a very great advance in iron manufacture. In common with some other metals, iron has so far resisted electrolytic treatment, but there can be no doubt that such a cold process *[Another kind of efficient "cold process" is envisioned.—EFM]* will ultimately replace in metallurgy the present crude method of casting, and thus obviating the enormous waste of fuel necessitated by the repeated heating of metal in the foundries.

Up to a few decades ago the usefulness of iron was based almost wholly on its remarkable mechanical properties, but since the advent of the commercial dynamo and electric motor its value to mankind has been greatly increased by its unique magnetic qualities. As regards the latter, iron has been greatly improved of late. The signal progress began

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about thirteen years ago, when I discovered that in using soft Bessemer steel instead of wrought iron, as then customary, in an alternating motor, the performance of the machine was doubled. I brought this fact to the attention of Mr. Albert Schmid, to whose untiring efforts and ability is largely due the supremacy of American electrical machinery, and who was then superintendent of an industrial corporation engaged in this field. Following my suggestion, he constructed transformers of steel, and they showed the same marked improvement. The investigation was then systematically continued under Mr. Schmid's guidance, the impurities being gradually eliminated from the "steel" (which was only such in name, for in reality it was pure soft iron), and soon a product resulted which admitted of little further improvement.

The Coming of Age of Aluminium: Doom of the Copper Industry—The Great Civilizing Potency of the New Metal

With the advances made in iron of late years we have arrived virtually at the limits of improvement. We cannot hope to increase very materially its tensile strength, elasticity, hardness, or malleability, nor can we expect to make it much better as regards its magnetic qualities. More recently a notable gain was secured by the mixture of a small percentage of nickel with the iron, but there is not much room for further advance in this direction. New discoveries may be expected, but they cannot greatly add to the valuable properties of the metal, though they may considerably reduce the cost of manufacture. The immediate future of iron is assured by its cheapness and its unrivaled mechanical and magnetic qualities. These are such that no other product can compete with it now. But there can be no doubt that, at a time not very distant, iron, in many of its now uncontested domains, will have to pass the scepter to another: the coming age will be the age of aluminium. It is only seventy years since this wonderful metal was discovered by Woehler, and the aluminium industry, scarcely forty years old, commands already the attention of the entire world. Such rapid growth has not been recorded in the history of civilization before. Not long ago aluminium was sold at the fanciful price of thirty or forty dollars per pound; today it can be had in any desired amount for as many cents. What is more, the time is not far off when this price, too, improvements are possible in the methods of its manufacture. Most of the metal is now produced in the electric furnace by a process combining fusion and electrolysis, which offers a number of advantageous features, but involves naturally a great waste of the electrical energy of the current. My estimates show that the price of aluminium could be considerably reduced by adopting in its manufacture a method similar to that iron. A pound of aluminium requires for fusion only about seventy percent. of the heat needed for melting a pound of iron, and inasmuch as its weight is only about one third of that of the latter, a volume of aluminium four times that of iron could be obtained from a given amount of heat-energy. But a cold electrolytic process of manufacture is the ideal solution, and on this I have placed my hope. *[Still another kind of efficient "cold process" is suggested.—EFM]*

The absolutely unavoidable consequence of the advancement of the aluminium industry will be the annihilation of the copper industry. *[This did not happen!—EFM]* They cannot exist and prosper together, and the latter is doomed beyond any hope of recovery. Even now it is cheaper to convey an electric current through aluminium wires than through copper wires; aluminium castings cost less, and in many domestic and other uses copper has no chance of successfully competing. A further material reduction of the price of aluminium cannot but be fatal to copper. But the progress of the former will not go on unchecked, for, as it ever happens in such cases, the larger industry will absorb the smaller one: the giant copper interests will control the pygmy aluminium interests, and the slow-pacing copper will reduce the lively gait of aluminium. This will only delay, not avoid the impending catastrophe.

Aluminium, however, will not stop at downing copper. Before many years have passed it will be engaged in a fierce struggle with iron, and in the latter it will find an adversary not easy to conquer. The issue of the contest will largely depend on whether iron shall be indispensable in electric machinery. This the future alone can decide. The magnetism as exhibited in iron is an isolated phenomenon in nature. What it is that makes this metal behave so radically different from all other materials in this respect has not yet been ascertained, though many theories have been suggested. As regards magnetism, the molecules of the various bodies behave like hollow beams partly filled with a heavy fluid and balanced in the middle in the manner of a see-saw. Evidently some disturbing influence exists in nature which causes each molecule, like such a beam, to tilt either one or the other way. If the molecules are tilted one way, the body is magnetic; if they are tilted the other way, the body is non-magnetic; but both positions are stable, as they would be in the case of the hollow beam, owing to the rush of the fluid to the lower end. Now, the wonderful thing is that the molecules of all known bodies went one way, while those of iron went the other way. This metal, it would seem, has an origin entirely different from that of the rest of the globe. It is highly improbable that we shall discover some other and cheaper material which will equal or surpass iron in magnetic qualities. *[The great visionary Tesla fails to foresee ceramic magnets, and the phenomena of superconductivity, which was first observed in 1911. However, the "age of iron" continued, nonetheless.—EFM]*

Unless we should make a radical departure in the character of the electric currents employed, iron will be indispensable. Yet the advantages it offers are only apparent. So long as we use feeble magnetic forces it is by far superior to any other material; but if we find ways of producing great magnetic forces, than better results will be obtainable without it. In fact, I have already produced electric transformers in which no iron is employed, and which are capable of performing ten times as much work per pound of weight as those of iron. This result is attained by using electric currents of a very high rate of vibration, produced in novel ways, instead of the ordinary currents now employed in the industries. I have also succeeded in operating electric motors without iron by such rapidly vibrating currents, but the results, so far, have been inferior to those obtained with ordinary motors constructed of iron, although theoretically the former should be capable of performing incomparably more work per unit of weight than the latter. But the seemingly insuperable difficulties which are now in the way may be overcome in the end, and then iron will be done away with,

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and all electric machinery will be manufactured of aluminium, in all probability, at prices ridiculously low. This would be a severe, if not fatal, blow to iron. In many other branches of industry, as ship-building, or wherever lightness of structure is required, the progress of the new metal will be much quicker. For such uses it is eminently suitable, and is sure to supersede iron sooner or later. It is highly probable that in the course of time we shall be able to give it many of those qualities which make iron so valuable.

While it is impossible to tell when this industrial revolution will be consummated, there can be no doubt that the future belongs to aluminium, and that in times to come it will be the chief means of increasing human performance. It has in this respect capacities greater by far than those of any other metal. I should estimate its civilizing potency at fully one hundred times that of iron. This estimate, though it may astonish, is not at all exaggerated. First of all, we must remember that there is thirty times as much aluminium as iron in bulk, available for the uses of man. This in itself offers great possibilities. Then, again, the new metal is much more easily workable, which adds to its value. In many of its properties it partakes of the character of a precious metal, which gives it additional worth. Its electric conductivity, which, for a given weight, is greater than that of any other metal, would be alone sufficient to make it one of the most important factors in future human progress. Its extreme lightness makes it far more easy to transport the objects manufactured. By virtue of this property it will revolutionize naval construction, and in facilitating transport and travel it will add enormously to the useful performance of mankind. But its greatest civilizing property will be, I believe, in aerial travel, which is sure to be brought about by means of it. *[Tesla firmly predicts widespread aviation—and the use of aluminum in its vehicles.—EFM]* Telegraphic instruments will slowly enlighten the barbarian. Electric motors and lamps will do it more quickly, but quicker than anything else the flying-machine will do it. By rendering travel ideally easy it will be the best means for unifying the heterogeneous elements of humanity. As the first step toward this realization we should produce a lighter storage-battery or get more energy from coal.

Efforts Toward Obtaining More Energy from Coal: The Electric Transmission, the Gas Engine, and the Cold-Coal Battery

I remember that at one time I considered the production of electricity by burning coal in a battery as the greatest achievement toward the advancing civilization, and I am surprised to find how much the continuous study of these subjects has modified my views. It now seems to me that to burn coal, however efficiently, in a battery would be a mere makeshift, a phase in the evolution toward something much more perfect. After all, in generating electricity in this manner, we should be destroying material, and this would be a barbarous process. We ought to be able to obtain the energy we need without consumption of material. *[Tesla makes an even stronger assertion that we should aim to invent "free energy" devices, which do not consume "material."—EFM]* But I am far from underrating the value of such an efficient method of burning fuel. At the present time most motive power comes from coal, and, either directly or by its products, it adds vastly to human energy. Unfortunately, in all the process now adopted, the larger portion of the energy of the coal is uselessly dissipated. The best steam-engines utilize only a small part of the total energy. Even in gas-engines, in which, particularly of late, better results are obtainable, there is still a barbarous waste going on. In our electric-lighting systems we scarcely utilize one third of one per cent., and in lighting by gas a much smaller fraction, of the total energy of the coal. Considering the various uses of coal throughout the world, we certainly do not utilize more than two percent of its energy theoretically available. The man who should stop this senseless waste would be a great benefactor of humanity, though the solution he would offer could not be a permanent one, since it would ultimately lead to the exhaustion of the store of material. Efforts toward obtaining more energy from coal are now being made chiefly in two directions—by generating electricity and by producing gas for motive-power purposes. In both of these lines notable success has already been achieved. *[And in 2003, the U.S. DOE continues to fund coal research!—EFM]*

The advent of the alternating-current system of electric power-transmission marks an available to man from coal. Evidently all electrical energy obtained from a waterfall, saving so much fuel, is a net gain to mankind, which is all the more effective as it is secured with little expenditure of human effort, and as this most perfect of all known methods of deriving energy from the Sun contributes in many ways to the advancement of civilization. But electricity enables us also to get from coal much more energy than was practicable in the old ways. Instead of transporting the coal to distant places of consumption, we burn it near the mine, develop electricity in the dynamos, and transmit the current to remote localities, thus effecting a considerable saving. Instead of driving the machinery in a factory in the old wasteful way of belts and shafting, we generate electricity by steam-power and operate electric motors. In this manner it is not uncommon to obtain two or three times as much effective motive power from the fuel, besides securing many other important advantages. It is in this field as much as in the transmission of energy to great distance that the alternating system, with its ideally simple machinery, is bringing about an industrial revolution. But in many lines this progress has not been yet fully felt. For example, steamers and trains are still being propelled by the direct application of steam-power to shafts or axles. A much greater percentage of the heat-energy of the fuel could be transformed into motive energy by using, in place of the adopted marine engines and locomotives, dynamos driven by specially designed high-pressure steam or gas-engines and by utilizing the electricity generated for the propulsion. A gain of fifty to one hundred percent in the effective energy derived from the coal could be secured in this manner. It is difficulty to understand why a fact so plain and obvious is not receiving more attention from engineers. In ocean steamers such an improvement would be particularly desirable, as it would do away with noise and increase materially the speed and the carrying capacity of the liners.

Still more energy is now being obtained from coal by the latest improved gas-engine, the economy of which is, on the average, probably twice that of the best steam-engine. The introduction of the gas-engine is very much facilitated by the importance of the gas industry. With the increasing use of the electric light more and more of the gas is utilized for

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heating and motive-power purposes. In many instances gas is manufactured close to the coal-mine and conveyed to distant places of consumption, a considerable saving both in cost of transportation and in utilization of the energy of the fuel being thus effected. In the present state of the mechanical and electrical arts the most rational way of deriving energy from coal is evidently to manufacture gas close to the coal store, and to utilize it, either on the spot or elsewhere, to generate electricity for industrial uses in dynamos driven by gas engines. The commercial success of such a plant is largely dependent upon the production of gas-engines of great nominal horse-power, which, judging from the keen activity in this field will soon be forthcoming. Instead of consuming coal directly, as usual, gas should be manufactured from it and burned to economize energy.

But all such improvements cannot be more than passing phases in the evolution toward something far more perfect, for ultimately we must succeed in obtaining electricity from coal in a more direct way, involving no great loss of heat-energy. Whether coal can be oxidized by a cold process is still a question. Its combination with oxygen always involves heat, and whether the energy of the combination of the carbon with another element can be turned directly into electrical energy has not yet been determined. Under certain conditions nitric acid will burn the carbon, generating an electric current, but the solution does not remain cold. Other means of oxidizing coal have been proposed, but they have offered no promise of leading to an efficient process. My own lack of success has been complete, though perhaps not quite so complete as that of some who have "perfected" the cold-coal battery. This problem is essentially one for the chemist to solve. It is not for the physicist, who determines all his results in advance, so that, when the experiment is tried, it cannot fail. Chemistry, though a positive science, does not yet admit of a solution by such positive methods as result, if possible, will be arrived at through patent trying rather than through deduction or calculation. The time will soon come, however, when the chemist will be able to follow a course clearly mapped out beforehand, and when the process of his arriving at a desired result will be purely constructive. The cold-coal battery would give a great impetus to electrical development; it would lead very shortly to a practical flying-machine, and would enormously enhance the introduction of the automobile. But these and many other problems will be better solved, and in a more scientific manner, by a light storage battery. *[A very interesting discourse by Tesla, comparing the methods of progress in chemistry versus those in physics. He is struggling to envision highly efficient energy generating processes that use cheap fuel, e.g. coal, but which do not waste heat.—EFM]*

Energy from the Medium: The Windmill and the Solar Engine—Motive Power from Terrestrial Heat, Electricity from Natural Sources

Besides fuel, there is abundant material from which we might eventually derive power. An immense amount of energy is locked up in limestone, for instance, and machines can be driven by liberating the carbonic acid through sulphuric acid or otherwise. I once constructed such an engine, and it operated satisfactorily.

But, whatever our resources of primary energy may be in the future, we must, to be rational, obtain it without consumption of any material. Long ago I came to this conclusion, and to arrive at this result only two ways, as before indicated, appeared possible—either to turn to use the energy of the Sun stored in the ambient medium, or to transmit, through the medium, the Sun's energy to distant places from some locality where it was obtainable without consumption of material. At that time I at once rejected the latter method as entirely impracticable, and turned to examine the possibilities of the former. *[Tesla sets forth two supreme goals: 1. To extract the energy of thermal motion in the environment (deriving ultimately from solar heating) and 2. To be able to transmit "through the medium" this free energy.—EFM]*

It is difficult to believe, but it is, nevertheless, a fact, that since time immemorial man has had at his disposal a fairly good machine which has enabled him to utilize the energy of the ambient medium. This machine is the windmill. Contrary to popular belief, the power obtainable from wind is very considerable. Many a deluded inventor has spent years of his life in endeavoring to "harness the tides," and some have even proposed to compress air by tide—or wave-power for supplying energy, never understanding the signs of the old windmill on the hill, as it sorrowfully waved its arms about and bade them stop. The fact is that a wave- or tide-motor would have, as a rule, but a small chance of competing commercially with the windmill, which is by far the better machine, allowing a much greater amount of energy to be obtained in a simpler way. Wind-power has been, in old times, of inestimable value to man, if for nothing else but for enabling him, to cross the seas, and it is even now a very important factor in travel and transportation. But there are great limitations in this ideally simple method of utilizing the Sun's energy. The machines are large for a given output, and the power is intermittent, thus necessitating the storage of energy and increasing the cost of the plant.

A far better way, however, to obtain power would be to avail ourselves of the Sun's rays, which beat the Earth incessantly and supply energy at a maximum rate of over four million horsepower per square mile. Although the average energy received per square mile in any locality during the year is only a small fraction of that amount, yet an inexhaustible source of power would be opened up by the discovery of some efficient method of utilizing the energy of the rays. The only rational way known to me at the time when I began the study of this subject was to employ some kind of heat—or thermodynamic-engine, driven by a volatile fluid evaporate in a boiler by the heat of the rays. But closer investigation of this method, and calculation, showed that, notwithstanding the apparently vast amount of energy received from the Sun's rays, only a small fraction of that energy could be actually utilized in this manner. Furthermore, the energy supplied through the Sun's radiations is periodical, and the same limitations as in the use of the windmill I found to exist here also. After a long study of this mode of obtaining motive power from the Sun, taking into account the necessarily large bulk of the boiler, the low efficiency of the heat-engine, the additional cost of storing the energy and other drawbacks, I came to the conclusion that the "solar engine," a few instances excepted, could not be industrially exploited with success. *[Tesla has identified many of the key, inherent problems that still plague "conventional" solar power and windpower. Yes, these have their place, but these power*

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sources are truly dead ends, compared to what Tesla has in mind. . .read on!—EFM]

Another way of getting motive power from the medium without consuming any material would be to utilize the heat contained in the Earth, the water, or the air for driving an engine. It is a well-known fact that the interior portions of the globe are very hot, the temperature rising, as observations show, with the approach to the center at the rate of approximately 1°C for every hundred feet of depth. The difficulties of sinking shafts and placing boilers at depths of, say, twelve thousand feet, corresponding to an increase in temperature of about 120°C, are not insuperable, and we could certainly avail ourselves in this way of the internal heat of the globe. In fact, it would not be necessary to go to any depth at all in order to derive energy from the stored terrestrial heat. The superficial layers of the Earth and the air str

Electricity produced by natural causes is another source of energy which might be rendered available. Lightning discharges involve great amounts of electrical energy, which we could utilize by transforming and storing it. Some years ago I made known a method of electrical transformation which renders the first part of this task easy, but the storing of the energy of lightning discharges will be difficult to accomplish. It is well known, furthermore, that electric currents circulate constantly through the Earth, and that there exists between the Earth and any air stratum a difference of electrical pressure, which varies in proportion to the height.

In recent experiments I have discovered two novel facts of importance in this connection. One of these facts is that an electric current is generated in a wire extending from the ground to a great height by the axial, and probably also by the translatory, movement of the Earth. No appreciable current, however, will flow continuously in the wire unless the electricity is allowed to leak out into the air. Its escape is greatly facilitated by providing at the elevated end of the wire a conducting terminal of great surface, with many sharp edges or points. We are thus enabled to get a continuous supply of electrical energy by merely supporting a wire at a height, but, unfortunately, the amount of electricity which can be so obtained is small.

The second fact which I have ascertained is that the upper air strata are permanently charged with electricity opposite to that of the Earth. So, at least, I have interpreted my observations, from which it appears that the Earth, with its adjacent insulating and outer conducting envelope, constitutes a highly charged electrical condenser containing, in all probability, a great amount of electrical energy which might be turned to the uses of man, if it were possible to reach with a wire to great altitudes.

It is possible, and even probable, that there will be, in time, other resources of energy opened up, of which we have no knowledge now. We may even find ways of applying forces such as magnetism or gravity for driving machinery without using any other means. Such realizations, though highly improbable, are not impossible. *[Tesla speculates on future sources of energy for which "we have no knowledge now." Nuclear energy would become one such source—apparently Tesla was not aware of the implications of radioactivity, discovered only a few years earlier in 1896.—EFM]* An example will best convey an idea of what we can hope to attain and what we can never attain. Imagine a disk of some homogeneous material turned perfectly true and arranged to turn in frictionless bearings on a horizontal shaft above the ground. This disk, being under the above conditions perfectly balanced, would rest in any position. Now, it is possible that we may learn how to make such a disk rotate continuously and perform work by the force of gravity without any further effort on our part; but it is perfectly impossible for the disk to turn and to do work without any force from the outside. If it could do so, it would be what is designated scientifically as a "perpetuum mobile," a machine creating its own motive power. To make the disk rotate by the force of gravity we have only to invent a screen against this force. By such a screen we could prevent this force from acting on one half of the disk, and the rotation of the latter would follow. At least, we cannot deny such a possibility until we know exactly the nature of the force of gravity. *[The brilliantly perceptive Tesla suggests that we should not rule out this "perpetuum mobile" based on a possible gravity shield, before we understand what gravity truly is.—EFM]* Suppose that this force were due to a movement comparable to that of a stream of air passing from above toward the center of the Earth. The effect of such a stream upon both halves of the disk would be equal, and the latter would not rotate ordinarily; but if one half should be guarded by a plate arresting the movement, then it would turn. *[Theories of "pushing gravity" via moving aetheric entities are still widely discussed in 2003, even in the dysfunctional era of belief by the mainstream that Einstein's General Theory of Relativity "explains" gravity.—EFM]*

A Departure from Known Methods: Possibility of a "Self-Acting" Engine or Machine, Inanimate, Yet Capable, Like a Living Being, of Deriving Energy from the Medium—The Ideal Way of Obtaining Motive Power

When I began the investigation of the subject under consideration, and when the preceding or similar ideas presented themselves to me for the first time, though I was then unacquainted with a number of the facts mentioned, a survey of the various ways of utilizing the energy of the medium convinced me, nevertheless, that to arrive at a thoroughly satisfactory practical solution a radical departure from the methods then known had to be made. The windmill, the solar engine, the engine driven by terrestrial heat, had their limitations in the amount of power obtainable. Some new way had to be discovered which would enable us to get more energy. There was enough heat-energy in the medium, but only a small part of it was available for the operation of an engine in the ways then known. Besides, the energy was obtainable only at a very slow rate. Clearly, then, the problem was to discover some new method which would make it possible both to utilize more of the heat-energy of the medium and also to draw it away from the same at a more rapid rate. *[Tesla is winding up to his grand conclusion that the Second Law of Thermodynamics can be defeated.—EFM]*

I was vainly endeavoring to form an idea of how this might be accomplished, when I read some statements from Carnot and Lord Kelvin (then Sir William Thomson) which meant virtually that it is impossible for an inanimate mechanism or self-acting machine to cool a portion of the medium below the temperature of the surrounding, and operate by the heat abstracted. *[Tesla accurately states what has come to be known as the Kelvin-Planck statement of the Second Law of*

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Thermodynamics.—EFM] These statements interested me intensely. Evidently a living being could do this very thing, and since the experiences of my early life which I have related had convinced me that a living being is only an automaton, or, otherwise stated, a "self-acting-engine," I came to the conclusion that it was possible to construct a machine which would do the same. As the first step toward this realization I conceived the following mechanism. Imagine a thermopile consisting of a number of bars of metal extending from the Earth to the outer space beyond the atmosphere. The heat from below, conducted upward along these metal bars, would cool the Earth or the sea or the air, according to the location of the lower parts of the bars, and the result, as is well known, would be an electric current circulating in these bars. The two terminals of the thermopile could now be joined through an electric motor, and, theoretically, this motor would run on and on, until the media below would be cooled down to the temperature of the outer space. This would be an inanimate engine which, to all evidence, would be cooling a portion of the medium below the temperature of the surrounding, and operating by the heat abstracted.

But was it not possible to realize a similar condition without necessarily going to a height? Conceive, for the sake of illustration, [a cylindrical] enclosure *T*, as illustrated in Diagram B, such that energy could not be transferred across it except through a channel or path *O*, and that, by some means or other, in this enclosure a medium were maintained which would have little energy, and that on the outer side of the same there would be the ordinary ambient medium with much energy. Under these assumptions the energy would flow through the path *O*, as indicated by the arrow, and might then be converted on its passage into some other form of energy. The question was, could such a condition be attained? Could we produce artificially such a "sink" for the energy of the ambient medium to flow in? Suppose that an extremely low temperature could be maintained by some process in a given space; the surrounding medium would then be compelled to give off heat, which could be converted into mechanical or other form of energy, and utilized. *[Tesla identifies the need to maintain a cold "sink"—or a "cold hole" as he later calls it—into which the heat energy of the surrounding medium would "fall." But how to maintain such a "cold hole" against destruction by infalling heat?—EFM]* By realizing such a plan, we should be enabled to get at any point of the globe a continuous supply of energy, day and night. More than this, reasoning in the abstract, it would seem possible to cause a quick circulation of the medium, and thus draw the energy at a very rapid rate.

Here, then, was an idea which, if realizable, afforded a happy solution of the problem of getting energy from the medium. But was it realizable? I convinced myself that it was so in a number of ways, of which one is the following. As regards heat, we are at a high level, which may be represented by the surface of a mountain lake considerably above the sea, the level of which may mark the absolute zero of temperature existing in the interstellar space. Heat, like water, flows from high to low level, and, consequently, just as we can let the water of the lake run down to the sea, so we are able to let heat from the Earth's surface travel up into the cold region above. Heat, like water, can perform work in flowing down, and if we had any doubt as to whether we could derive energy from the medium by means of a thermopile, as before described, it would be dispelled by this analogue. But can we produce cold in a given portion of the space and cause the heat to flow in continually? To create such a "sink," or "cold hole," as we might say, *[Perhaps the first ever use of the term "cold hole"?—EFM]* in the medium, would be equivalent to producing in the lake a space either empty or filled with something much lighter than water. This we could do by placing in the lake a tank, and pumping all the water out of the latter. We know, then, that the water, if allowed to flow back into the tank, would, theoretically, be able to perform exactly the same amount of work which was used in pumping it out, but not a bit more. Consequently nothing could be gained in this double operation of first raising the water and then letting it fall down. This would mean that it is impossible to create such a sink in the medium. But let us reflect a moment. Heat, though following certain general laws of mechanics, like a fluid, is not such; it is energy which may be converted into other forms of energy as it passes from a high to a low level. To make our mechanical analogy complete and true, we must, therefore, assume that the water, in its passage into the tank, is converted into something else, which may be taken out of it without using any, or by using very little, power. For example, if heat be represented in this analogue by the water of the lake, the oxygen and hydrogen composing the water may illustrate other forms of energy into which the heat is transformed in passing from hot to cold. If the process of heat transformation were absolutely perfect, no heat at all would arrive at the low level, since all of it would be converted into other forms of energy. Corresponding to this ideal case, all the water flowing into the tank would be decomposed into oxygen and hydrogen before reaching the bottom, and the result would be that water would continually flow in, and yet the tank would remain entirely empty, the gases formed escaping. We would thus produce, by expending initially a certain amount of work to create a sink for the heat or, respectively, the water to flow in, a condition enabling us to get any amount of energy without further effort. This would be an ideal way of obtaining motive power. We do not know of any such absolutely perfect process of heat-conversion, and consequently some heat will generally reach the low level, which means to say, in our mechanical analogue, that some water will arrive at the bottom of the tank, and a gradual and slow filling of the latter will take place, necessitating continuous pumping out. But evidently there will be less to pump out than flows in, or, in other words, less energy will be needed to maintain the initial condition than is developed by the fall, and this is to say that some energy will be gained from the medium. What is not converted in flowing down can just be raised up with its

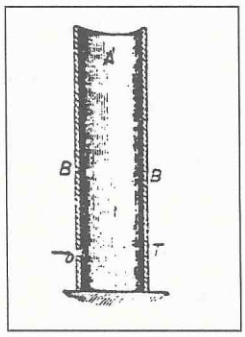

Diagram B. Obtaining energy from the ambient medium: *A*, medium with little energy; *B*, ambient medium with much energy; *O*, path of the energy.

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own energy, and what is converted is clear gain. Thus the virtue of the principle I have discovered resides wholly in the conversion of the energy on the downward flow. *[Though Tesla has not conceived the exact principle by which the "cold hole" can be prevented from destruction, he appears to be hot on the trail of the general approach to be taken.—EFM]*

First Efforts to Produce the Self-Acting Engine: The Mechanical Oscillator, Work of Dewar and Linde, Liquid Air

Having recognized this truth, I began to devise means for carrying out my idea, and, after long thought, I finally conceived a combination of apparatus which should make possible the obtaining of power from the medium by a process of continuous cooling of atmospheric air. This apparatus, by continually transforming heat into mechanical work, tended to become colder and colder, and if it only were practicable to reach a very low temperature in this manner, then a sink for the heat could be produced, and energy could be derived from the medium. This seemed to be contrary to the statements of Carnot and Lord Kelvin before referred to, but I concluded from the theory of the process that such a result could be attained. This conclusion I reached, I think, in the latter part of 1883, when I was in Paris, and it was at a time when my mind was being more and more dominated by an invention which I had evolved during the preceding year, and which has since become known under the name of the "rotating magnetic field." *[Here Tesla states that his ideas for developing a "self-acting engine" violating the Second Law of Thermodynamics were in progress at the time he was planning his rotating magnetic field generators, which launched the era of distributed AC power.—EFM]* During the few years which followed I elaborated further the plan I had imagined, and studied the working conditions, but made little headway. The commercial introduction in this country of the invention before referred to required most of my energies until 1889, when I again took up the idea of the self-acting machine. A closer investigation of the principles involved, and calculation, now showed that the result I aimed at could not be reached in a practical manner by ordinary machinery, as I had in the beginning expected. This led me, as a next step, to the study of a type of engine generally designated as "turbine," which at first seemed to offer better chances for a realization of the idea. Soon I found, however, that the turbine, too, was unsuitable. But my conclusions showed that if an engine of a peculiar kind could be brought to a high degree of perfection, the plan I had conceived was realizable, and I resolved to proceed with the development of such an engine, the primary object of which was to secure the greatest economy of transformation of heat into mechanical energy. A characteristic feature of the engine was that the work-performing piston was not connected with anything else, but was perfectly free to vibrate at an enormous rate. The mechanical difficulties encountered in the construction of this engine were greater than I had anticipated, and I made slow progress. This work was continued until early in 1892, when I went to London, where I saw Professor Dewar's admirable experiments with liquefied gases. Others had liquefied gases before, and notably Ozlewski and Pictet had performed creditable early experiments in this line, but there was such a vigor about the work of Dewar that even the old appeared new. His experiments showed, though in a way different from that I had imagined, that it was possible to reach a very low temperature by transforming heat into mechanical work, and I returned, deeply impressed with what I had seen, and more than ever convinced that my plan was practicable. The work temporarily interrupted was taken up anew, and soon I had in a fair state of perfection the engine which I have named "the mechanical oscillator." In this machine I succeeded in doing away with all packings, valves, and lubrication, and in producing so rapid a vibration of the piston that shafts of tough steel, fastened to the same and vibrated longitudinally, were torn asunder. By combining this engine with a dynamo of special design I produced a highly efficient electrical generator, invaluable in measurements and determinations of physical quantities on account of the unvarying rate of oscillation obtainable by its means. I exhibited several types of this machine, named "mechanical and electrical oscillator," before the Electrical Congress at the World's Fair in Chicago during the summer of 1893, in a lecture which, on account of other pressing work, I was unable to prepare for publication. On that occasion I exposed the principles of the mechanical oscillator, but the original purpose of this machine is explained here for the first time.

In the process, as I had primarily conceived it, for the utilization of the energy of the ambient medium, there were five essential elements in combination, and each of these had to be newly designed and perfected, as no such machines existed. The mechanical oscillator was the first element of this combination, and having perfected this, I turned to the next, which was an air-compressor of a design in certain respects resembling that of the mechanical oscillator. Similar difficulties in the construction were again encountered, but the work was pushed vigorously, and at the close of 1894 I had completed these two elements of the combination, and thus produced an apparatus for compressing air, virtually to any desired pressure, incomparably simpler, smaller, and more efficient than the ordinary. I was just beginning work on the third element, which together with the first two would give a refrigerating machine of exceptional efficiency and simplicity, when a misfortune befell me in the burning of my laboratory, which crippled my labors and delayed me. *[This was the terrible tragedy of the fire in his lab in 1895.—EFM]* Shortly afterward Dr. Carl Linde announced the liquefaction of air by a self-cooling process, demonstrating that it was practicable to proceed with the cooling until liquefaction of the air took place. This was the only experimental proof which I was still wanting that energy was obtainable from the medium in the manner contemplated by me.

The liquefaction of air by a self-cooling process was not, as popularly believed, an accidental discovery, but a scientific result which could not have been delayed much longer, and which, in all probability, could not have escaped Dewar. This fascinating advance, I believe, is largely due to the powerful work of this great Scotchman. Nevertheless, Linde's is an immortal achievement. The manufacture of liquid air has been carried on for four years in Germany, on a scale much larger than in any other country, and this strange product has been applied for a variety of purposes. Much was expected of it in the beginning, but so far it has been an industrial ignis fatuus. By the use of such machinery as I am perfecting, its cost will

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probably be greatly lessened, but even then its commercial success will be questionable. When, used as a refrigerant it is uneconomical, as its temperature is unnecessarily low. It is as expensive to maintain a body at a very low temperature as it is to keep it very hot; it takes coal to keep air cold. In oxygen manufacture it cannot yet compete with the electrolytic method. For use as an explosive it is unsuitable, because its low temperature again condemns it to a small efficiency, and for motive-power purposes its cost is still by far too high. It is of interest to note, however, that in driving an engine by liquid air a certain amount of energy may be gained from the engine, or, stated otherwise, from the ambient medium which keeps the engine warm, each two hundred pounds of iron-casting of the latter contributing energy at the rate of about one effective horsepower during one hour. But this gain of the consumer is offset by an equal loss of the producer.

Much of this task on which I have labored so long remains to be done. A number of mechanical details are still to be perfected and some difficulties of a different nature to be mastered, and I cannot hope to produce a self-acting machine deriving energy from the ambient medium for a long time yet, even if all my expectations should materialize. Many circumstances have occurred which have retarded my work of late, but for several reasons the delay was beneficial. *[Tesla in the above has made statements akin to the famous mathematician, Fermat, who wrote in the margin of a book that he had a "simple proof" of his remarkable mathematical theorem—a notation which challenged mathematicians for the following 300 years or so until his Theorem was ultimately proved. Tesla, like Fermat, probably did not possess a "simple proof" of his idea, in this case "the self-acting engine" that would use environmental heat.—EFM]*

One of these reasons was that I had ample time to consider what the ultimate possibilities of this development might be. I worked for a long time fully convinced that the practical realization of this method of obtaining energy from the Sun would be of incalculable industrial value, but the continued study of the subject revealed the fact that while it will be commercially profitable if my expectations are well founded, it will not be so to an extraordinary degree. *[Apparently Tesla does not think such a machine would be economically viable, though it could be made **in principle**!—EFM]*

Discovery of Unexpected Properties of the Atmosphere: Strange Experiments, Transmission of Electrical Energy Through One Wire Without Return, Transmission Through the Earth Without Any Wire

Another of these reasons was that I was led to recognize the transmission of electrical energy to any distance through the media as by far the best solution of the great problem of harnessing the Sun's energy for the uses of man. For a long time I was convinced that such a transmission on an industrial scale, could never be realized, but a discovery which I made changed my view. I observed that under certain conditions the atmosphere, which is normally a high insulator, assumes conducting properties, and so becomes capable of conveying any amount of electrical energy. But the difficulties in the way of a practical utilization of this discovery for the purpose of transmitting electrical energy without wires were seemingly insuperable. Electrical pressures of many millions of volts had to be produced and handled; generating apparatus of a novel kind, capable of withstanding the immense electrical stresses, had to be invented and perfected, and a complete safety against the dangers of the high-tension currents had to be attained in the system before its practical introduction could be even thought of. All this could not be done in a few weeks or months, or even years. The work required patience and constant application, but the improvements came, though slowly. Other valuable results were, however, arrived at in the course of this long-continued work, of which I shall endeavor to give a brief account, enumerating the chief advances as they were successively effected.

The discovery of the conducting properties of the air, though unexpected, was only a natural result of experiments in a special field which I had carried on for some years before. It was, I believe, during 1889 that certain possibilities offered by extremely rapid electrical oscillations determined me to design a number of special machines adapted for their investigation. Owing to the peculiar requirements, the construction of these machines was very difficult, and consumed much time and effort; but my work on them was generously rewarded, for I reached by their means several novel and important results. One of the earliest observations I made with these new machines was that electrical oscillations of an extremely high rate act in an extraordinary manner upon the human organism. Thus, for instance, I demonstrated that powerful electrical discharges of several hundred thousand volts, which at that time were considered absolutely deadly, could be passed through the body without inconvenience or hurtful consequences. These oscillations produced other specific physiological effects, which, upon my announcement, were eagerly taken up by skilled physicians and further investigated. This new field has proved itself fruitful beyond expectation, and in the few years which have passed since, it has been developed to such an extent that it now forms a legitimate and important department of medical science. Many results, thought impossible at that time, are now readily obtainable with these oscillations, and many experiments undreamed of then can now be readily performed by their means. I still remember with pleasure how, nine years ago, I passed the discharge of a powerful induction-coil through my body to demonstrate before a scientific society the comparative harmlessness of very rapidly vibrating electric currents, and I can still recall the astonishment of my audience. I would now undertake, with much less apprehension that I had in that experiment, to transmit through my body with such currents the entire electrical energy of the dynamos now working at Niagara—forty or fifty thousand horse-power. I have produced electrical oscillations which were of such intensity that when circulating through my arms and chest they have melted wires which joined my hands, and still I felt no inconvenience. I have energized with such oscillations a loop of heavy copper wire so powerfully that masses of metal, and even objects of an electrical resistance specifically greater than that of human tissue brought close to or placed within the loop, were heated to a high temperature and melted, often with the violence of an explosion, and yet into this very space in which this terribly-destructive turmoil was going on I have repeatedly thrust my head without feeling anything or experiencing injurious after-effects. *[In the foregoing remarkable descriptions, Tesla is referring*

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to manifestations of electricity not accepted or understood by the mainstream, even in 2003! Clearly, in order for his descriptions to make sense, there must be something very profound that conventional electromagnetic theory has missed about the kind of electric action that Tesla described, and its relation to the human body—and to organisms in general.—EFM]

Another observation was that by means of such oscillations light could be produced in a novel and more economical manner, which promised to lead to an ideal system of electric illumination by vacuum-tubes, dispensing with the necessity of renewal of lamps or incandescent filaments, and possibly also with the use of wires in the interior of buildings. The efficiency of this light increases in proportion to the rate of the oscillations, and its commercial success is, therefore, dependent on the economical production of electrical vibrations of transcending rates. In this direction I have met with gratifying success of late, and the practical introduction of this new system of illumination is not far off.

The investigations led to many other valuable observations and results, one of the more important of which was the demonstration of the practicability of supplying electrical energy through one wire without return. At first I was able to transmit in this novel manner only very small amounts of electrical energy, but in this line also my efforts have been rewarded with similar success. *[This foreshadowed the remarkable work of Wilhelm Reich in the U.S., and later the Correas in Canada, who have produced devices that employ "electric currents," which indeed travel through single wires without return! The Correas call this "ambipolar massfree radiation," a component of the supposed non-existent aether. The much ignored and misunderstood field of all aspects of bioelectricity will return with a vengeance early in the twenty-first century. It will transform all of biology, I predict.—EFM]*

The photograph shown in Figure 3 illustrates, as its title explains, an actual transmission of this kind effected with apparatus used in other experiments here described. To what a degree the appliances have been perfected since my first demonstrations early in 1891 before a scientific society, when my apparatus was barely capable of lighting one lamp (which result was considered wonderful), will appear when I state that I have now no difficulty in lighting in this manner four or five hundred lamps, and could light many more. In fact, there is no limit to the amount of energy which may in this way be supplied to operate any kind of electrical device.

After demonstrating the practicability of this method of transmission, the thought naturally occurred to me to use the Earth as a conductor, thus dispensing with all wires. Whatever electricity may be, it is a fact that it behaves like an incompressible fluid, and the Earth may be looked upon as an immense reservoir of electricity, which, I thought, could be disturbed effectively by a properly designed electrical machine. *[Tesla wrote this only three years after the identification of the **electron** as a fundamental unit of electricity. Later, the term "electricity" would become firmly associated with the flow of these massbound charge carriers, electrons. But in Tesla's day, and especially for him, electricity was more generally an incompressible **fluid**. The Earth was a reservoir of this fluid. Actually, he was touching on theories of aether structure which would become engaged much later in the twentieth century, though certainly not by the brain-dead mainstream, which insists that "electricity" is **always** the movement of massbound charge carriers.—EFM]* Accordingly, my next efforts were directed toward perfecting a special apparatus which would be highly effective in creating a disturbance of electricity in the Earth. The progress in this new direction was necessarily very slow and the work discouraging, until I finally succeeded in perfecting a novel kind of transformer or induction-coil, particularly suited for this special purpose. That it is practicable, in this manner, not only to transmit minute amounts of electrical energy for operating delicate electrical devices, as I contemplated at first, but also electrical energy in appreciable quantities, will appear from an inspection of Figure 4, which illustrates an actual experiment of this kind performed with the same apparatus. The result obtained was all the more remarkable as the top end of the coil was not connected to a wire or plate for magnifying the effect.

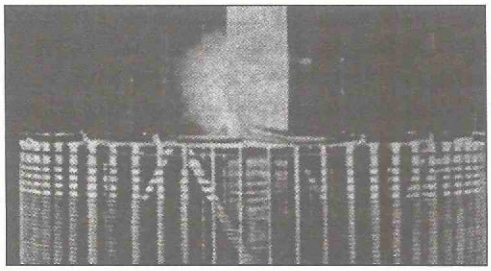

Figure 3. Experiment to illustrate the supplying of electrical energy through a single wire without return. An ordinary incandescent lamp, connected with one or both of its terminals to the wire forming the upper free end of the coil shown in the photograph, is lighted by electrical vibrations conveyed to it through the coil from an electrical oscillator, which is worked only to one fifth of one percent of its full capacity.

"Wireless" Telegraphy: The Secret of Tuning, Errors in the Hertzian Investigations, a Receiver of Wonderful Sensitiveness

As the first valuable result of my experiments in this latter line a system of telegraphy without wires resulted, which I described in two scientific lectures in February and March, 1893. It is mechanically illustrated in Diagram C, the upper part of which shows the electrical arrangement as I described it then, while the lower part illustrates its mechanical analogue. The system is extremely simple in principle. Imagine two tuning-forks F, F_1, one at the sending- and the other at the receiving-station respectively, each having attached to its lower prong a minute piston p, fitting in a cylinder. Both the cylinders communicate with a large reservoir R, with elastic walls, which is supposed to be closed and filled with a light and incompressible fluid. By striking repeatedly one of the prongs of the tuning-fork F, the small piston p below would be vibrated, and its vibrations, transmitted through the fluid, would reach the distant fork F_1, which is "tuned" to the fork F, or, stated otherwise, of exactly the same note as the latter. The fork F_1 would now be set vibrating, and its vibration would be intensified by the continued action of the distant fork F until its upper prong, swinging far out, would make an electrical connection with a stationary contact c'', starting in this manner some electrical or other appliances which may be used for recording the signals. In this simple way messages could be exchanged between the two stations, a similar contact c, being provided for this purpose,

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close to the upper prong of the fork *F*, so that the apparatus at each station could be employed in turn as receiver and transmitter.

The electrical system illustrated in the upper figure of Diagram C is exactly the same in principle, the two wires or circuits *ESP* and $E_1S_1P_1$, which extend vertically to a height, representing the two tuning-forks with the pistons attached to them. These circuits are connected with the ground by plates *E*, E_1, and to two elevated metal sheets *P*, P_1, which store electricity and thus magnify considerably the effect. The closed reservoir *R*, with elastic walls, is in this case replaced by the Earth, and the fluid by electricity. Both of these circuits are "tuned" and operate just like the two tuning-forks. Instead of striking the fork *F* at the sending-station, electrical oscillations are produced in the vertical sending- or transmitting-wire *ESP*, as by the action of a source *S*, included in this wire, which spread through the ground and reach the distant vertical receiving-wire $E_1S_1P_1$, exciting corresponding electrical oscillations in the same. In the latter wire or circuit is included a sensitive device or receiver S_1, which is thus set in action and made to operate a relay or other appliance. Each station is, of course, provided both with a source of electrical oscillations *S* and a sensitive receiver S_1, and a simple provision is made for using each of the two wires alternately to send and to receive the messages.

The exact attunement of the two circuits secures great advantages, and, in fact, it is essential in the practical use of the system. In this respect many popular errors exist, and, as a rule, in the technical reports on this subject circuits and appliances are described as affording these advantages when from their very nature it is evident that this is impossible. In order to attain the best results it is essential that the length of each wire or circuit, from the ground connection to the top, should be equal to one quarter of the wave-length of the electrical vibration in the wire, or else equal to that length multiplied by an odd number. Without the observation of this rule it is virtually impossible to prevent the interference and insure the privacy of messages. Therein lies the secret of tuning. To obtain the most satisfactory results it is, however, necessary to resort to electrical vibrations of low pitch. The Hertzian spark apparatus, used generally by experimenters, which produces oscillations of a very high rate, permits no effective tuning, and slight disturbances are sufficient to render an exchange of messages impracticable. But scientifically designed, efficient appliances allow nearly perfect adjustment. An experiment performed with the improved apparatus repeatedly referred to, and intended to convey an idea of this feature, is illustrated in Figure 5, which is sufficiently explained by its note.

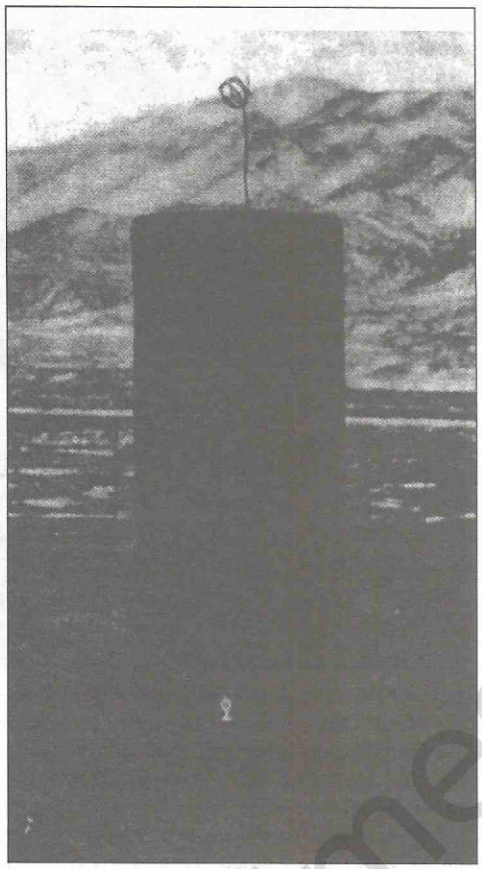

Figure 4. Experiment to illustrate the transmission of electrical energy through the earth without wire. The coil shown in the photograph has its lower end or terminal connected to the ground, and is exactly attuned to the vibrations of a distant electrical oscillator. The lamp lighted is in an independent wire loop, energized by induction from the coil excited by the electrical vibrations transmitted to it through the ground from the oscillator, which is worked only to five percent of its full capacity.

Since I described these simple principles of telegraphy without wires I have had frequent occasion to note that the identical features and elements have been used, in the evident belief that the signals are being transmitted to considerable distance by "Hertzian" radiations. This is only one of many misapprehensions to which the investigations of the lamented physicist have given rise. About thirty-three years ago Maxwell, following up a suggestive experiment made by Faraday in 1845, evolved an ideally simple theory which intimately connected light, radiant heat, and electrical phenomena, interpreting them as being all due to vibrations of a hypothetical fluid of inconceivable tenuity, called the ether. No experimental verification was arrived at until Hertz, at the suggestion of Helmholtz, undertook a series of experiments to this effect. Hertz proceeded with extraordinary ingenuity and insight, but devoted little energy to the perfection of his old-fashioned apparatus. The consequence was that he failed to observe the important function which the air played in his experiments, and which I subsequently discovered. Repeating his experiments and reaching different results, I ventured to point out this oversight. The strength of the proofs brought forward by Hertz in support of Maxwell's theory resided in the correct estimate of the rates of vibration of the circuits he used. But I ascertained that he could not have obtained the rates he thought he was getting. The vibrations with identical apparatus he employed are, as a rule, much slower, this being due to the presence of air, which produces a dampening effect upon a rapidly vibrating electric circuit of high pressure, as a fluid does upon a vibrating tuning-fork. I have, however, discovered since

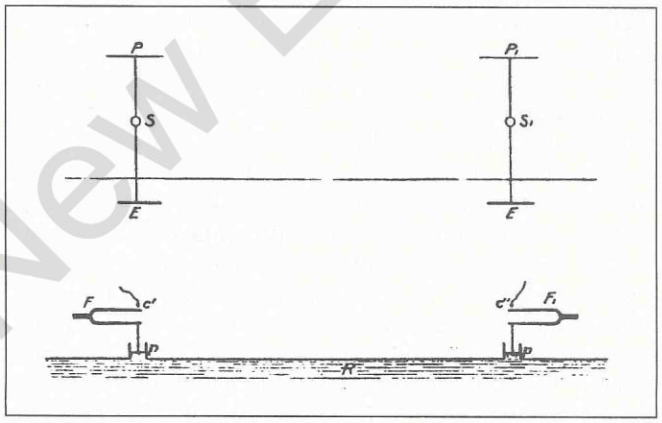

Diagram C. "Wireless" telegraphy mechanically illustrated.

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that time other causes of error, and I have long ago ceased to look upon his results as being an experimental verification of the poetical conceptions of Maxwell. The work of the great German physicist has acted as an immense stimulus to contemporary electrical research, but it has likewise, in a measure, by its fascination, paralyzed the scientific mind, and thus hampered independent inquiry. *[Every new phenomenon which was discovered was made to fit the theory, and so very often the truth has been unconsciously distorted. [Editor's underlining for emphasis! Tesla identifies the nature of theory-driven errors, which were to come to pervade twentieth century physics. Indeed, the* ***experimentally driven*** *ether (aether) physics with which Tesla was grappling was soon to be replaced by a rigid electromagnetic theory dogma, overlaid with even more dogmatic, rigid, and fundamentally wrong, Einsteinian relativities!—EFM]*

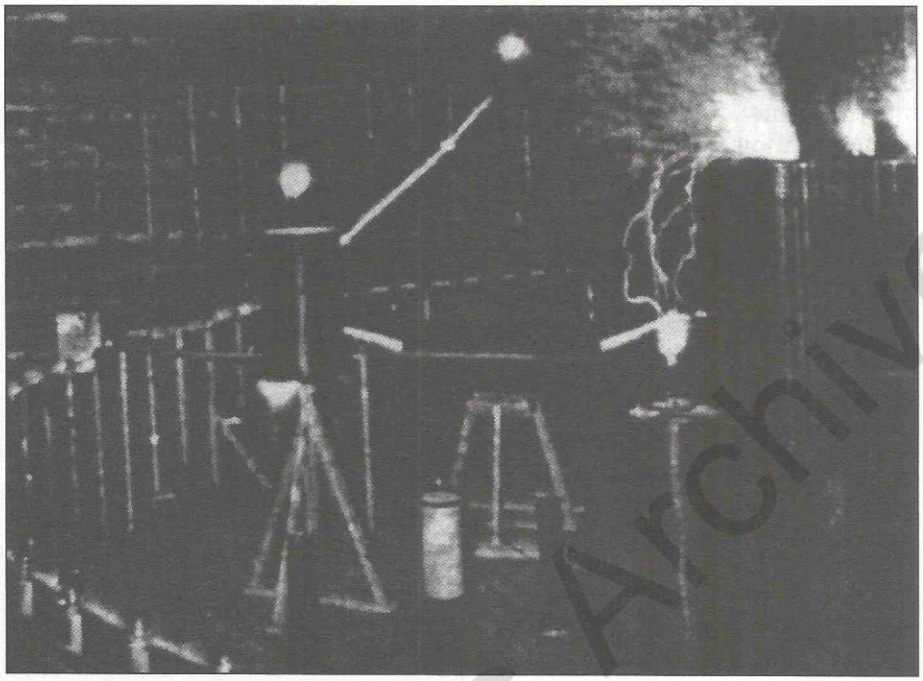

Figure 5. Photographic view of the coils responding to electrical oscillations. The picture shows a number of coils, differently attuned and responding to the vibrations transmitted to them through the Earth from an electrical oscillator. The large coil on the right, discharging strongly, is tuned to the fundamental vibration, which is fifty thousand per second; the two larger vertical coils to twice that number; the smaller white wire coil to four times that number, and the remaining small coils to higher tones. The vibrations produced by the oscillator were so intense that they affected perceptibly a small coil tuned to the twenty-sixth higher tone.

When I advanced this system of telegraphy, my mind was dominated by the idea of effecting communication to any distance through the Earth or environing medium, the practical consummation of which I considered of transcendent importance, chiefly on account of the moral effect which it could not fail to produce universally. As the first effort to this end I proposed at that time, to employ relay-stations with tuned circuits, in the hope of making thus practicable signaling over vast distances, even with apparatus of very moderate power then at my command. I was confident, however, that with properly designed machinery signals could be transmitted to any point of the globe, no matter what the distance, without the necessity of using such intermediate stations. *[Tesla was, indeed, the discoverer and patenter of the basic principles of radio communication. Unfortunately, the misconception lingers that Marconi was the original pioneer of radio. He was not.—EFM]* I gained this conviction through the discovery of a singular electrical phenomenon, which I described early in 1892, in lectures I delivered before some scientific societies abroad, and which I have called a "rotating brush." This is a bundle of light which is formed, under certain conditions, in a vacuum-bulb, and which is of a sensitiveness to magnetic and electric influences bordering, so to speak, on the supernatural. This light-bundle is rapidly rotated by the Earth's magnetism as many as twenty thousand times per second, the rotation in these parts being opposite to what it would be in the southern hemisphere, while in the region of the magnetic equator it should not rotate at all. In its most sensitive state, which is difficult to obtain, it is responsive to electric or magnetic influences to an incredible degree. The mere stiffening of the muscles of the arm and consequent slight electrical change in the body of an observer standing at some distance from it, will perceptibly affect it. When in this highly sensitive state it is capable of indicating the slightest magnetic and electric changes taking place in the Earth. The observation of this wonderful phenomenon impressed me strongly that communication at any distance could be easily effected by its means, provided that apparatus could be perfected capable of producing an electric or magnetic change of state, however small, in the terrestrial globe or environing medium.

Development of a New Principle: The Electrical Oscillator, Production of Immense Electrical Movements, the Earth Responds to Man, Interplanetary Communication Now Probable

I resolved to concentrate my efforts upon this venturesome task, though it involved great sacrifice, for the difficulties to be mastered were such that I could hope to consummate it only after years of labor. It meant delay of other work to which I would have preferred to devote myself, but I gained the conviction that my energies could not be more usefully employed; for I recognized that an efficient apparatus for, the production of powerful electrical oscillations, as was needed for that specific purpose, was the key to the solution of other most important electrical and, in fact, human problems. Not only was communication, to any distance, without wires possible by its means, but, likewise, the transmission of energy in great amounts, the burning of the atmospheric nitrogen, the production of an efficient illuminant, and many other results of inestimable scientific and industrial value. Finally, however, I had the satisfaction of accomplishing the task undertaken by the use of a new principle,

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the virtue of which is based on the marvelous properties of the electrical condenser. One of these is that it can discharge or explode its stored energy in an inconceivably short time. Owing to this it is unequaled in explosive violence. The explosion of dynamite is only the breath of a consumptive compared with its discharge. It is the means of producing the strongest current, the highest electrical pressure, the greatest commotion in the medium. Another of its properties, equally valuable, is that its discharge may vibrate at any rate desired up to many millions per second.

I had arrived at the limit of rates obtainable in other ways when the happy idea presented itself to me to resort to the condenser. I arranged such an instrument so as to be charged and discharged alternately in rapid succession through a coil with a few turns of stout wire, forming the primary of a transformer or induction-coil. Each time the condenser was discharged the current would quiver in the primary wire and induce corresponding oscillations in the secondary. Thus a transformer or induction-coil on new principles was evolved, which I have called "the electrical oscillator," partaking of those unique qualities which characterize the condenser, and enabling results to be attained impossible by other means. Electrical effects of any desired character and of intensities undreamed of before are now easily producible by perfected apparatus of this kind, to which frequent reference has been made, and the essential parts of which are shown in Figure 6. For certain purposes a strong inductive effect is required; for others the greatest possible suddenness; for others again, an exceptionally high rate of vibration or extreme pressure; while for certain other objects immense electrical movements are necessary. The photographs in Figures 7, 8, 9, and 10, of experiments performed with such an oscillator, may serve to illustrate some of these features and convey an idea of the magnitude of the effects actually produced. The completeness of the titles of the figures referred to makes a further description of them unnecessary.

However extraordinary the results shown may appear, they are but trifling compared with those which are attainable by apparatus designed on these same principles. I have produced electrical discharges the actual path of which, from end to end, was probably more than one hundred feet long; but it would not be difficult to reach lengths one hundred times as great. I have produced electrical movements occurring at the rate of approximately one hundred thousand horse-power, but rates of one, five, or ten million horse-power are easily practicable. In these experiments effects were developed incomparably greater than any ever produced by human agencies, and yet these results are but an embryo of what is to be.

That communication without wires to any point of the globe is practicable with such apparatus would need no demonstration, but through a discovery which I made I obtained absolute certitude. Popularly explained, it is exactly this: When we raise the voice and hear an echo in reply, we know that the sound of the voice must have reached a distant wall, or boundary, and must have been reflected from the same. Exactly as the sound, so an electrical wave is reflected, and the same evidence which is afforded by an echo is offered by an electrical phenomenon known as a "stationary" wave—that is, a wave with fixed nodal and ventral regions. Instead of sending sound-vibrations toward a distant wall, I have sent electrical vibrations toward the remote boundaries of the Earth, and instead of the wall the Earth has replied. In place of an echo I have obtained a stationary electrical wave, a wave reflected from afar.

Stationary waves in the Earth mean something more than mere telegraphy without wires to any distance. They will enable us to attain many important specific results impossible otherwise. For instance, by their use we may produce at will, from a sending-station, an electrical effect in any particular region of the globe; we may determine the relative position or course of a moving object, such as a vessel at sea, the distance traversed by the same, or its speed; *[Tesla is envisioning electromagnetic detection methods akin to radar.—EFM]* or we may send over the Earth a wave of electricity traveling at any rate we desire, from the pace of a turtle up to lightning speed.

With these developments we have every reason to anticipate that in a time not very distant most telegraphic messages across the oceans will be transmitted without cables. For short distances we need a "wireless" telephone, which requires no expert operators. The greater the spaces to be bridged, the more rational becomes communication without wires. The cable is

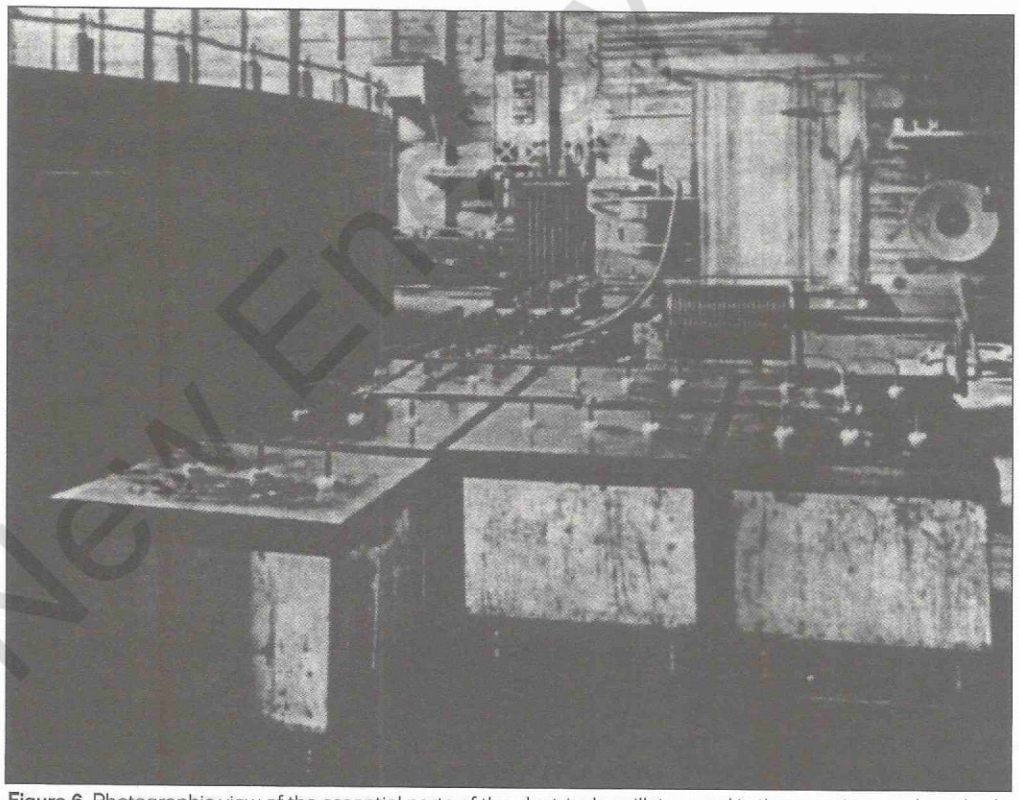

Figure 6. Photographic view of the essential parts of the electrical oscillator used in the experiments described.

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not only an easily damaged and costly instrument, but it limits us in the speed of transmission by reason of a certain electrical property inseparable from its construction. A properly designed plant for effecting communication without wires ought to have many times the working capacity of a cable, while it will involve incomparably less expense. Not a long time will pass, I believe, before communication by cable will become obsolete, for not only will signaling by this new method be quicker and cheaper, but also much safer. By using some new means for isolating the messages which I have contrived, an almost perfect privacy can be secured.

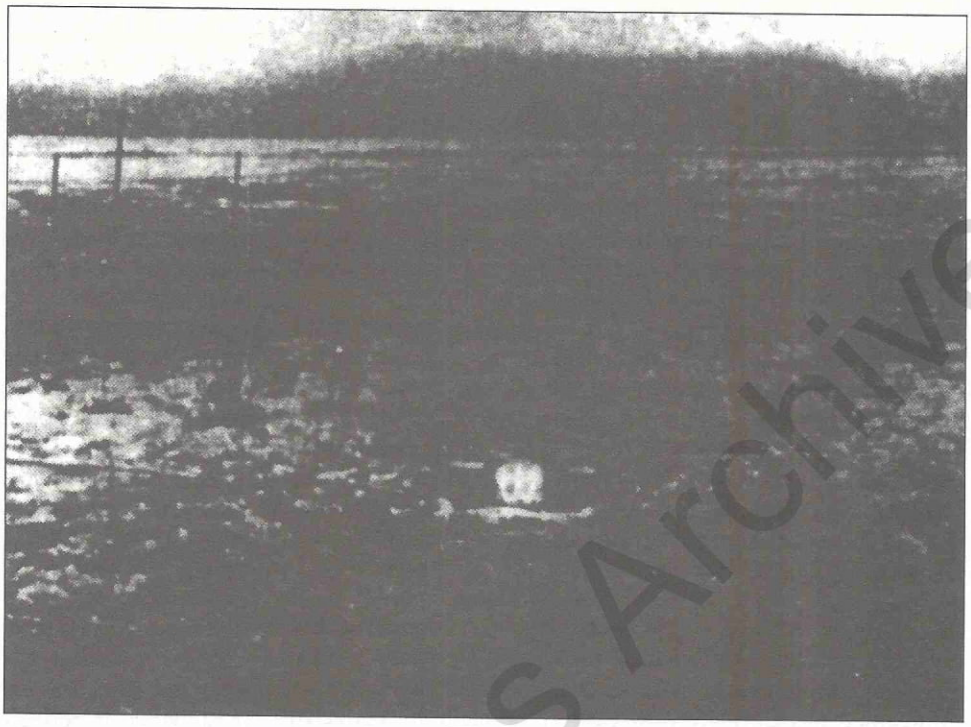

Figure 7. Experiment to illustrate an inductive effect of an electrical oscillator of great power. The photograph shows three ordinary incandescent lamps lighted to full candle-power by currents induced in a local loop consisting of a single wire forming a square of fifty feet each side, which includes the lamps, and which is at a distance of one hundred feet from the primary circuit energized by the oscillator. The loop likewise includes an electrical condenser, and is exactly attuned to the vibrations of the oscillator, which is worked at less than five percent of its total capacity.

I have observed the above effects so far only up to a limited distance of about six hundred miles, but inasmuch as there is virtually no limit to the power of the vibrations producible with such an oscillator, I feel quite confident of the success of such a plant for effecting transoceanic communication. Nor is this all. My measurements and calculations have shown that it is perfectly practicable to produce on our globe, by the use of these principles, an electrical movement of such magnitude that, without the slightest doubt, its effect will be perceptible on some of our nearer planets, as Venus and Mars. Thus from mere possibility interplanetary communication has entered the stage of probability. *[Indeed, by the mid-twentieth century, radio communication with spacecraft at interplanetary distances was realized.—EFM]* In fact, that we can produce a distinct effect on one of these planets in this novel manner, namely, by disturbing the electrical condition of the Earth, is beyond any doubt. This way of effecting such communication is, however, essentially different from all others which have so far been proposed by scientific men. In all the previous instances only a minute fraction of the total energy reaching the planet—as much as it would be possible to concentrate in a reflector—could be utilized by the supposed observer in his instrument. But by the means I have developed he would be enabled to concentrate the larger portion of the entire energy transmitted to the planet in his instrument, and the chances of affecting the latter are thereby increased many millionfold. *[This is a remarkable statement about the ability to collimate the energy sent to the distant planet such that it is all captured in a receiver—not sure what Tesla is proposing here.—EFM]*

Besides machinery for producing vibrations of the required power, we must have delicate means capable of revealing the effects of feeble influences exerted upon the Earth. For such purposes, too, I have perfected new methods. By their use we shall likewise be able, among other things, to detect at considerable distance the presence of an iceberg or other object at sea. By their use, also, I have discovered some terrestrial phenomena still unexplained. That we can send a message to a planet is certain, that we can get an answer is probable: man is not the only being in the Infinite gifted with a mind. *[Tesla's firm opinion that other intelligent beings exist in the cosmos. He may be hinting that he thinks he has already received communications from distant worlds.—EFM]*

Transmission of Electrical Energy to Any Distance Without Wires—Now Practicable, the Best Means of Increasing the Force Accelerating the Human Mass

The most valuable observation made in the course of these investigations was the extraordinary behavior of the atmosphere toward electric impulses of excessive electromotive force. The experiments showed that the air at the ordinary pressure became distinctly conducting, and this opened up the wonderful prospect of transmitting large amounts of electrical energy for industrial purposes to great distances without wires, a possibility which, up to that time, was thought of only as a scientific dream. Further investigation revealed the important fact that the conductivity imparted to the air by these electrical impulses of many millions of volts increased very rapidly with the degree of rarefaction, so that air strata at very moderate altitudes, which are easily accessible, offer, to all experimental evidence, a perfect conducting path, better than a copper wire, for currents of this character.

Thus the discovery of these new properties of the atmosphere not only opened up the possibility of transmitting, without wires, energy in large amounts, but, what was still more significant, it afforded the certitude that energy could be transmitted in this manner economically. In this new system it matters little—in fact, almost nothing—whether the

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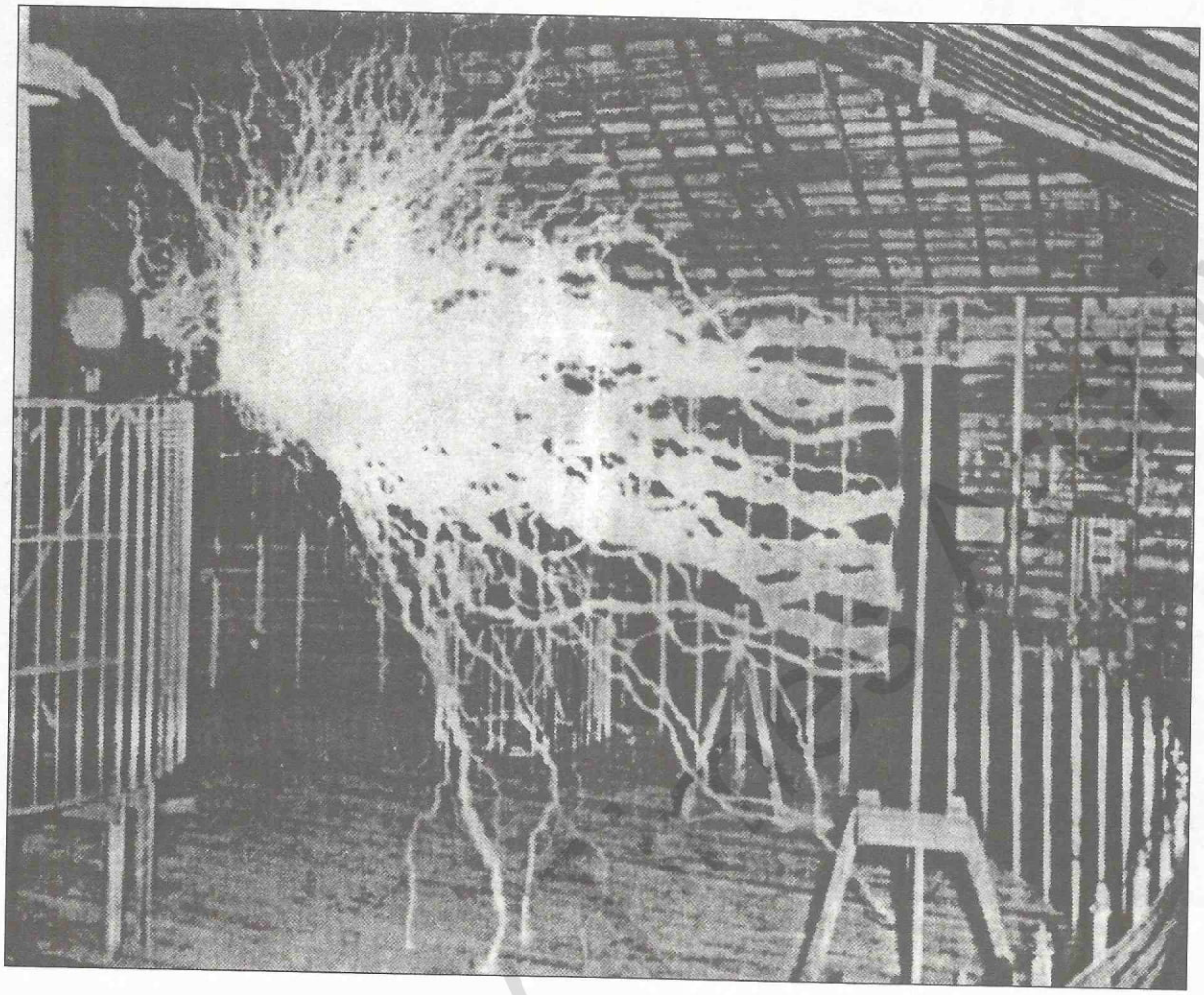

Figure 8. Experiment to illustrate the capacity of the oscillator for producing electrical explosions of great power. The coil, partly shown in the photograph, creates an alternative movement of electricity from the earth into a large reservoir and back at a rate of one hundred thousand alternations per second. The adjustments are such that the reservoir is filled full and bursts at each alternation just at the moment when the electrical pressure reaches the maximum. The discharge escapes with a deafening noise, striking an unconnected coil twenty-two feet away, and creating such a commotion of electricity in the earth that sparks an inch long can be drawn from a water main at a distance of three hundred feet from the laboratory.

transmission is effected at a distance of a few miles or of a few thousand miles. *[Tesla's dream of transmitting electric power* ***economically*** *through space is yet unfulfilled. His famous Wardenclyffe tower for power and radio message transmission, begun a few years after this essay was written, was destroyed and sold for scrap by 1917.—EFM]*

While I have not, as yet, actually effected a transmission of a considerable amount of energy, such as would be of industrial importance, to a great distance by this new method, I have operated several model plants under exactly the same conditions which will exist in a large plant of this kind, and the practicability of the system is thoroughly demonstrated. The experiments have shown conclusively that, with two terminals maintained at an elevation of not more than thirty thousand to thirty-five thousand feet above sea-level, and with an electrical pressure of fifteen to twenty million volts, the energy of thousands of horse-power can be transmitted over distances which may be hundreds and, if necessary, thousands of miles. I am hopeful, however, that I may be able to reduce very considerably the elevation of the terminals now required, and with this object I am following up an idea which promises such a realization. There is, of course, a popular prejudice against using an electrical pressure of millions of volts, which may cause sparks to fly at distances of hundreds of feet, but, paradoxical as it may seem, the system, as I have described it in a technical publication, offers greater personal safety than most of the ordinary distribution circuits now used in the cities. This is, in a measure, borne out by the fact that, although I have carried on such experiments for a number of years, no injury has been sustained either by me or any of my assistants.

But to enable a practical introduction of the system, a number of essential requirements are still to be fulfilled. It is not enough to develop appliances by means of which such a transmission can be effected. The machinery must be such as to allow the transformation and transmission, of electrical energy under highly economic and practical conditions. Furthermore, an inducement must be offered to those who are engaged in the industrial exploitation of natural sources

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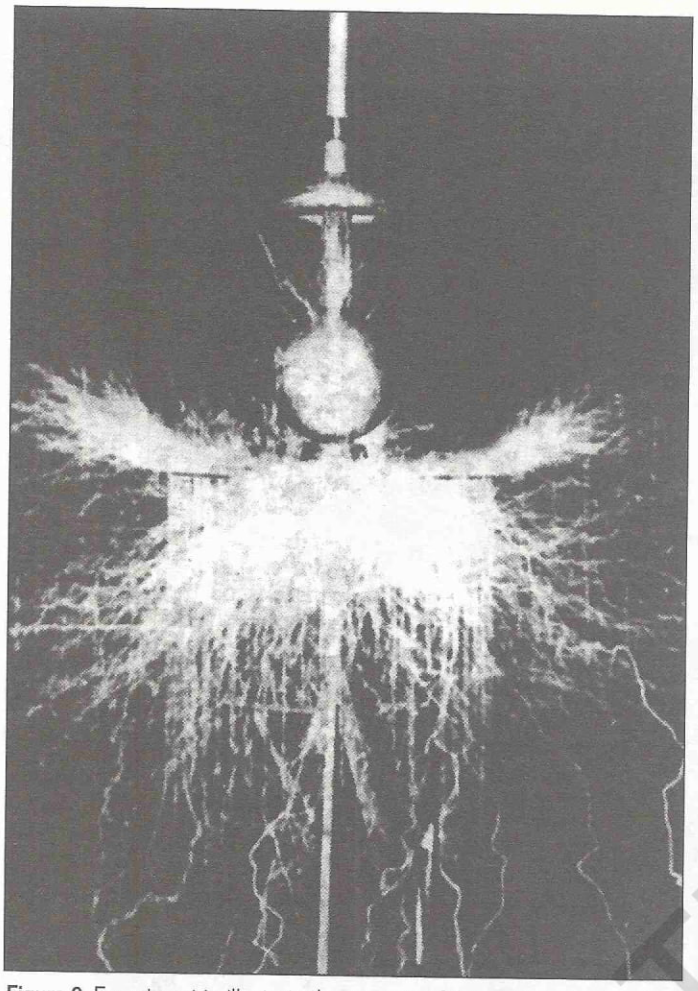


Figure 9. Experiment to illustrate the capacity of the oscillator for creating a great electrical movement. The ball shown in the photograph, covered with a polished metallic coating of twenty square feet of surface, represents a large reservoir of electricity, and the inverted tin pan underneath, with a sharp rim, a big opening through which the electricity can escape before filling the reservoir. The quantity of electricity set in movement is so great that, although most of it escapes through the rim of the pan or opening provided, the ball or reservoir is nevertheless alternately emptied and filled to over-flowing (as is evident from the discharge escaping on the top of the ball) one hundred and fifty thousand times per second.

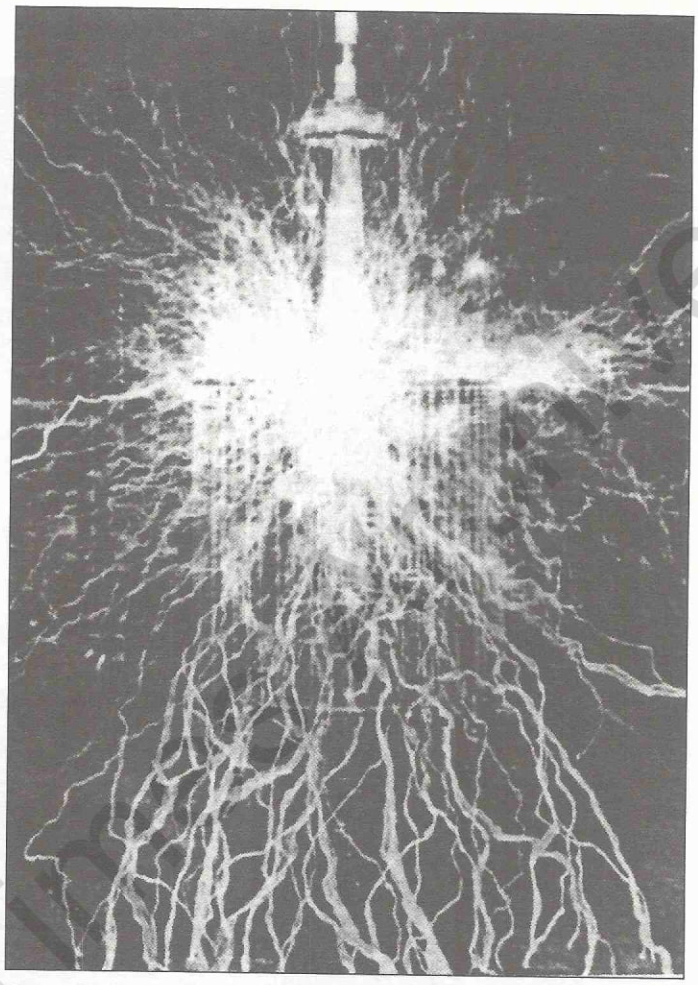


Figure 10. Photographic view of an experiment to illustrate an effect of an electrical oscillator delivering energy at a rate of seventy-five thousand horse-power. The discharge, creating a strong draft owing to the heating of the air, is carried upward through the open roof of the building. The greatest width across is nearly seventy feet. The pressure is over twelve million volts, and the current alternates one hundred and thirty thousand times per second.

of power, as waterfalls, by guaranteeing greater returns on the capital invested than they can secure by local development of the property.

From that moment when it was observed that, contrary to the established opinion, low and easily accessible strata of the atmosphere are capable of conducting electricity, the transmission of electrical energy without wires has become a rational task of the engineer, and one surpassing all others in importance. Its practical consummation would mean that energy would be available for the uses of man at any point of the globe, not in small amounts such as might be derived from the ambient medium by suitable machinery *[The self-acting engine that would use environmental heat.—EFM],* but in quantities virtually unlimited, from waterfalls. Export of power would then become the chief source of income for many happily situated countries, as the United States, Canada, Central and South America, Switzerland, and Sweden. Men could settle down everywhere, fertilize and irrigate the soil with little effort, and convert barren deserts into gardens, and thus the entire globe could be transformed and made a fitter abode for mankind. *[The means of effecting a free energy revolution is projected to be by transmission of power. Tesla did not realize that it would be possible to tap locally the aether medium and extract energy in situ. Still, the great man was the prophet of the emerging New Energy Age—a man far ahead of his time.—EFM]* It is highly probable that if there are intelligent beings on Mars they have long ago realized this very idea, which would explain the changes on its surface noted by astronomers. *[He was referring to the mis-perceived "canals" of Mars, which astronomer Percival Lowell at the time was touting as evidence for a global Martian civilization.—EFM]* The atmosphere on that planet, being of considerably smaller density than that of the Earth, would make the task much more easy.

It is probable that we shall soon have a self-acting heat-engine capable of deriving moderate amounts of energy from the ambient medium. There is also a possibility—though a small one—that we may obtain electrical energy direct from the Sun. This might be the case if the Maxwellian theory is true, according to which electrical vibrations of all rates should emanate from the Sun. I am still investigating this subject. Sir William Crookes has shown in his beautiful invention known as the "radiometer" that rays may produce by impact a mechanical effect, and this may lead to some important revelation as to

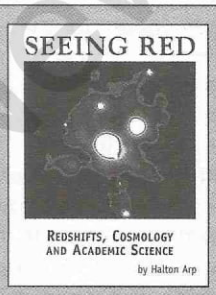
the utilization of the Sun's rays in novel ways. Other sources of energy may be opened up, and new methods of deriving energy from the Sun discovered, but none of these or similar achievements would equal in importance the transmission of power to any distance through the medium. *[Tesla, though a visionary who was tickling the genie of ether physics in many of his experiments, seemed not to be able to conceive of in situ power extraction from the ether. Nor was he able to conceive of nuclear energy, and the low-energy nuclear reactions (LENR) that emerged in the "cold fusion" revolution, which started in 1989.—EFM]* I can conceive of no technical advance which would tend to unite the various elements of humanity more effectively than this one, or of one which would more add to and more economize human energy. *[What Tesla said remains true—free energy would be the ultimate revolution in the human condition.—EFM]* It would be the best means of increasing the force accelerating the human mass. The mere moral influence of such a radical departure would be incalculable. On the other hand if at any point of the globe energy can be obtained in limited quantities from the ambient medium by means of a self-acting heat-engine or otherwise, the conditions will remain the same as before. Human performance will be increased, but men will remain strangers as they were. *[This is a puzzling conclusion!—EFM]*

I anticipate that any, unprepared for these results, which, through long familiarity, appear to me simple and obvious, will consider them still far from practical application. Such reserve, and even opposition, of some is as useful a quality and as necessary an element in human progress as the quick receptivity and enthusiasm of others. Thus, a mass which resists the force at first, once set in movement, adds to the energy. The scientific man does not aim at an immediate result. He does not expect that his advanced ideas will be readily taken up. His work is like that of the planter—for the future. His duty is to lay the foundation for those who are to come, and point the way. He lives and labors and hopes with the poet who says:

Daily work—my hands' employment,
To complete is pure enjoyment!
Let, oh, let me never falter!
No! there is no empty dreaming:
Lo! these trees, but bare poles seeming,
Yet will yield both food and shelter!

Goethe's "Hope"
Translated by William Gibson, Com. U.S.N.

The scientific man does not aim at an immediate result. He does not expect that his advanced ideas will be readily taken up. His work is like that of the planter—for the future.



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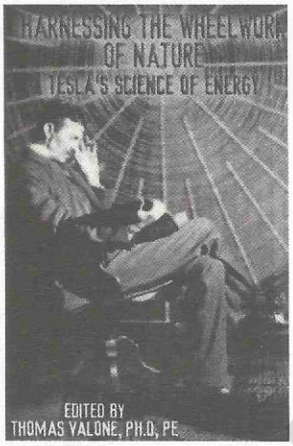

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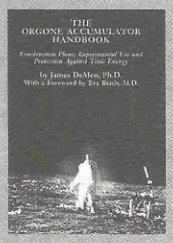

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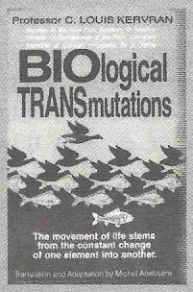

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Tesla and the Aether

Eugene F. Mallove

It is the opinion of conventional science that the universe consists of just this: mass (embodied in particles such as electrons, protons, neutrons, and various anti-matter particles) and electromagnetic radiation (visible light, radio waves, ultraviolet and infrared radiation, X-rays, gamma rays, etc.). All of this "stuff" is embedded, as it were, in what is called a space-time plenum, which supposedly emerged into existence, from previous non-existence, in a fraction of a second of "cosmic time" (some 15 billion years ago in "cosmic time"—this just in on February 12, 2003 from the *New York Times*, "Confirmed"! 13.7 billion years ±200 million years ago). For some reason, universal "cosmic time" is alright to talk about, as distinct from curved or flat "space-time," which we mortals must be confined to, according to Einstein's Special Relativity theory; we cannot have our Time and our Space separately, or so we are told; no one's Time is the same Time as that of another, who is moving relative to him or her.

In conventional science, all the "stuff" of the universe fills a regime of cosmic *nothingness*, with quantum mechanical electromagnetic fluctuations at an extremely small sub-atomic level filling up this "nothingness"—the so-called zero-point energy. Virtual particles supposedly pop in and pop out of existence—unpredictably, chaotically, randomly—to satisfy or not satisfy mass-energy conservation. Recently more baggage has been added to this cosmic picture by conventional science: It feels a need to augment the universe with so far unidentified "dark matter," "dark energy," "quintessence," and a seemingly interminable epicyclic bestiary of imagined creatures to help patch up the Big Bang with its primary structural feature, curved space-time, as dictated by General Relativity. This is Einstein's theory that supposedly "explains" gravity, but which does no such thing. Then there are the string theorists and the extra-dimensional universe theorists, with all their mathematical gymnastics that aim at explaining this increasingly muddied, quite ugly picture. Each of them longs to win that vaunted measure of nobility in science today, the Nobel Prize, for his or her contribution to the grand Theory of Everything.

An all-pervading "dark energy" is the latest Establishment darling, which is supposedly accelerating the imagined expansion of the universe. Said expansion is critically dependent on the measured cosmic red-shifts in light being truly of *cosmic* significance, not merely *local*-to-the-observed galaxy or quasar, *i.e.* of *new physics* significance—but that is another depressing story of the failures of Fizzix to consider possible major cracks in its foundations. A seemingly endless parade of stories in the news media evidences this infatuation with "dark energy." One MIT-trained physicist, Dr. Adam Riess, working at the Space Telescope Institute in Maryland five years ago, helped get the "dark energy" bandwagon going with his analysis of distant supernovae observations.

Add this unknown "dark energy" essence to the "stuff" that Modern Physics believes comprises existence—it's supposed to constitute some 75% of the "weight" of the cosmos, writes Dennis Overbye in his *New York Times* profile of Riess, February 18, 2003. More adulation for Einstein comes from the new universe "accelerating expansion" explanation, writes Overbye: "The leading explanation, so far, Dr. Riess said, is Einstein and his old fudge factor, the cosmological constant. According to modern quantum theory, the emptiness of space foams with evanescent particles, and their energy should act as an antigravity." (One recalls that this Einsteinian "fudge factor" was previously regarded as Albert's "greatest blunder"!) New projects and money aplenty are now flowing as the dark energy feeding frenzy has taken off. One project is dubbed "Essence"—believe it or not. We have yet to hear of any of these space projects being designated, "Aether." Too bad. Such a code name might prompt a return to bench-top experiments with Tesla coils (more on this later). Overbye quotes Riess in an embarrassing gaffe, the absurdity of which neither writer nor astrophysicist can comprehend (neither subscribes to *Infinite Energy*): "I would like what we find to be real, not spurious. The only thing I would really find disappointing is if at the end someone came along and said, 'You guys really screwed up your measurements.' I don't want it to be like cold fusion. I want it to be a part of science that has to be weaved into the studies of supernovae." Riess then recalls his memory of cold fusion, perhaps when he was at MIT: "Free energy for everybody." But with cold fusion's presumed demise, it became, he states, "a bizarre thing that had no place in science. I would hate that we become synonymous with cold fusion." Riess opines that it is unlikely that dark energy will go that way.

We are far from the time of nineteenth century and early twentieth century Nikola Tesla, when experiment and the concrete technological device *based on experiment* was the ultimate arbiter of Truth. Today we live in establishment science's world of Absolute Fiction. In this world, hundreds of experiments

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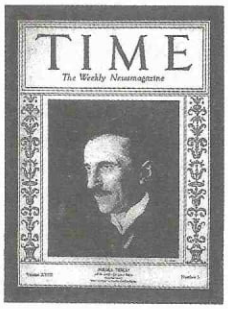
that show irrefutable evidence of nuclear reactions occurring at low-energy (LENR/"cold fusion") can be dumped into the trash bin of alleged scientific failure—to cite one example of many such trashings. When Tesla worked, another very serious component of the universe was very much a critical topic of discussion among physicists— the *ether* (or *aether*). This was the postulated finely structured substance that simply *had* to exist, if there was to be any hope of explaining how light waves were to travel through what otherwise would be just a vacuum of absolute "nothingness." James Clerk Maxwell, who gave us the first version of the equations used in electromagnetic theory today, certainly believed in an aether—the *luminifereous*, static one that carried light. As he wrote in the Ninth Edition of *Encyclopedia Britannica* (which began appearing around 1875), "The only aether which has survived is that which was invented by Huygens to explain the propagation of light. The evidence for the existence of the luminiferous aether has accumulated as additional phenomena of light and other radiations have been discovered; and the properties of this medium, as deduced from the phenomena of light, have been found to be precisely those required to explain electromagnetic phenomena." By the time of the 11th Edition of *Britannica* (1910), the aether was still alive and well—five pages of fine print and mathematics in Volume 1 discuss the concept and experimental questions about the aether in great detail, even the null interferometer result for the *static* aether, as obtained by A.A. Michelson in the 1880s. Active questioning about the possibility of a *dynamic* (moving) aether was at the fore in the 11th Edition. The article closed in a very upbeat way, promising that much new was yet to be discovered about the aether: "Finally, reference should be made to the phenomena of radioactivity, whether excited by the electric discharge in vacuum tubes, foreshadowed in part by Sir Wm. Crookes and G. G. Stokes, and later by A. Schuster and others, but first fully developed with astonishing results including the experimental discovery of the free electron by J.J. Thomson, or the correlated phenomena occurring spontaneously in radio-active bodies as discovered by H. Becquerel and by M. and Mme. Cure, and investigated by them and by E. Rutherford and others. These results constitute a far-reaching development of the modern or electrodynamic theory of the aether, of which the issue can hardly yet be foreseen." Yes, even electricity, previously an unknown aetheric fluid, was becoming identified, in part, with the newly discovered electron. Matters of atomic transformation were just beginning to be divined. Had an electrochemist been around then with an accurate calorimeter, excess heat in ordinary water electrolysis in nickel/platinum systems might have been discovered at the turn of the century! And, it would then have been accepted, not attacked. The world of physics was open and in ferment. The right path could have been taken, but it was not.

J. J. Thomson

It is 2003, and establishment science long ago threw out any serious discussion of the aether and its measurement. This it did long before it trashed LENR. Who needed or now needs an aether, when one had "space-time," multi-dimensions, vibrating strings—all wrapped up nicely in academic budgets? Who needs LENR—and spectral and calorimetric evidence that electron clouds around nuclei are not what standard QM says they are—when one has $1.5 billion of newly minted DOE money for *hot* fusion?

But the ghost of the aether is back. The spirit of Nikola Tesla lives and there is much unfinished business at hand for physics. A sane, experimentally-based cosmic view may yet be rescued from what masquerades as an increasingly "perfected" so-called Modern Physics. For me it was "cold fusion" that provided the wake up call. Cold fusion was like a canary brought into a deep mine to test its atmosphere. The canary died—proving conclusively that it was possible for late twentieth century establishment science to viciously attack anything, no matter how well-established experimentally, if the discovery did not seem to fit prevailing theories—and, indeed, cold fusion does *not* fit prevailing theories. And, if the *easy* transmutation phenomena associated with cold fusion/LENR (sans even direct electric energy input!) continues to be as prominent a feature as I think it will, the cold fusion canary will have served a further clarifying purpose: Present LENR theories, virtually all of them, which attempt to disconnect from more foundational questions about physics, such as the aether and potentially lethal challenges to quantum mechanics, are likely utterly doomed. Frankly, heroic and temporarily useful as were these lattice dynamics theories of Schwinger, Hagelestein, the Chubbs *et al.*, they are almost certainly doomed. To understand cold fusion/LENR—the "nuclear active environment" or "NAE" as investigator Dr. Edmund Storms terms it—we will most surely have to return to fundamental questions about electricity and the aether.

What did Tesla think about the aether? For that matter, what did Tesla think of "electricity"? We must remember that when the nineteenth century Tesla worked, the aether was inextricably connected with the concept of electricity—in addition to its being the medium of the transmission of light and other Hertzian electromagnetic waves. The idea of "particles of electricity"—later to be discovered and then called "electrons"—was not yet in vogue. Electricity was thought of as something like an intangible fluid—literally "etheric." In a seminal talk before the American Institute of Electrical Engineers (AIEE) in May 1891 at what was then called Columbia College in New York City, Tesla spoke these telling words: "Of all the forms of nature's immeasurable, all-pervading energy, which ever and ever change and move, like a soul animates an innate universe, electricity and magnetism are perhaps the most fascinating. . .We know that electricity acts like an incompressible fluid; that there must be a constant quantity of it in nature; that it can neither be produced or destroyed. . .and that electricity and ether phenomena are identical."[1] Tesla noted that this "ether" was everywhere moving and dynamic. The use of the ether would be the salvation of humankind, he said: ". . .with the power derived from it, with every form of energy obtained without effort, from stores forever inexhaustible, humanity will advance with giant strides." He said, ". . .it is a mere question of time when men will succeed in attaching their machinery to the very wheelwork of nature."



Of course, in Tesla's lifetime the wheelwork of nature—the ether/aether—was not harnessed. It was to become very much out of style to be talking about an aether—any kind of aether, static or dynamic. The advent of Albert Einstein's relativity theory had begun to abolish the aether from the physicists vocabulary in the 1920s and

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1930s. Yet when *Time* magazine put Tesla on its cover in celebrating his 75th birthday (July 10, 1931), it referred to Tesla's work toward harnessing an "entirely new and unsuspected [energy] source." Was this from the aether? Perhaps.

Tesla had long hoped to be able to distribute electric power globally through the medium of the aether, power generated at the transmission point with benign and unlimited sources such as hydroelectric power. The power would be consumed only as needed at millions of receivers, being carried to each within the resonating cavity surrounding the body of the Earth. Such power would be transmitted not by "electromagnetic radiation," as we ordinarily think of it (oscillating electric and magnetic waves *transverse* to the direction of propagation), but by *longitudinal* waves, which were more akin to longitudinal pressure waves in the air—the propagation of sound. He had conducted many experiments that seemed to show that such non-electromagnetic power propagation was possible. Indeed, Tesla illuminated electric bulbs at good distances. But was this really a new form of energy propagation? Indeed, it seems to have been.

We should first consider Nikola Tesla's special induction coils, which are called "Tesla Coils" these days. There they sit in dusty physical science class supply cabinets. They are sold by Edmund Scientific and other companies as classroom demonstrations of arcs and sparks. Supposedly the only thing circulating in these coils or out of them is all that modern physics knows about or expects to be there—*electrons* for the "electricity" that can be in the wires of the coils, and "electromagnetic radiation" that can emanate from these coils. There can be no such thing as "*longitudinal* waves" emanating from such coils—everyone *knows* that electromagnetic radiation is a *transverse* wave (from side-to-side perpendicular to the direction of propagation) electric and magnetic phenomenon in the nothingness of space-time, right? Well, let us see. . .

For a long time, good experimenters have been puzzled about the workings of Tesla coils. Many articles about these coils and related matters have appeared in the excellent publication, *Electric Spacecraft Journal*.[2] But that is only a beginning, and from the constraining physics of considering these coils to be exclusively electromagnetic field radiators with an electrostatic component. It seems, however, that Tesla coils are rich, indeed, with clues to the very structure of a dynamic aether. My own experience with matters aetheric did not begin with Tesla coils. It started with the puzzling and dramatic claims for excess electric power generation in Pulsed Abnormal Glow Discharge (PAGD™) tubes of Dr. Paulo and Alexandra Correa, which were profiled in Issues #7, 8, and 9 of *Infinite Energy* back in 1996. These are high vacuum glass tubes, typically with aluminum cathodes and anodes, which self-oscillate in a particular *negative resistance* region of current and voltage. That patented technology indeed has a significant over-unity characteristic (approximately 10/1 power ratio, according to my own observations made in the Correa laboratory much later in 2000-2002), of the type that has been generically associated by "free energy" researchers with zero point energy ("ZPE") extraction. Indeed, that type of quantum-mechanical "aether" is about as far as most speculators about free energy are willing to go. This follows from a lingering need to hold onto something perceived to be semi-respectable and citeable from twentieth century physics. That is a good first approximation, but it is evidently not the full picture—and it may well be far from it.

After PAGD, I learned that the Correas in parallel had begun to make more fundamental thermal and electroscopic measurements of what they had begun to infer from the work of Wilhelm Reich (1897-1957) was a dynamic, non-luminiferous (non-electromagnetic) aether. One of the centerpieces of this work apparently has allowed further detailed physics and mathematical understanding of what Tesla could only dimly perceive with his special high-frequency coils.[3,4,5] If this experimental work, closely coupled with theory, is ultimately successful in recovering a new *laboratory-testable* recognized physics in the realm of electricity and magnetism, it will owe its foundations to that mostly unsung genius, Nikola Tesla.

In an elaborate series of experiments with Tesla coils,[3] employing a host of different thermal and electric sensing apparatus (mercury thermometers, electroscopes, GM counters, oscilloscopes, neon bulb indicators within circuitry, Faraday cages, and plate antennas) at different ranges from the coil tips, and using comparison energy sources (various ion generators and radioactive sources), the Correas were able to rule out what Tesla coil radiation is *not*, and to synthesize what it may well be. They conclude that Tesla coils emit a special form of massfree radiation that is not electromagnetic in character and not sourced in ionic emissions. They observed that these "Tesla waves alone were capable of triggering the ratemeter via the plate antenna even at substantial distances." They suggest that the pulsed input to the primary of the Tesla coil "induces in the space of the closely coupled secondary a conversion of the local aether energy to electric form." They write, "All happens as if these coils synthesized two different kinds of electric fields, one proximal [near the coil] and massbound, and the other massfree and responsible for all distal [distant from the coil] effects."

At root, these experiments touch on the deep issue of the aether and its relation to what are evidently two basic forms of electricity, the *accepted* form (massbound, the flow of electrons), and other *not accepted* at all by conventional science, massfree—capable of flowing in and around wires, as well as being transmitted as Tesla waves through gas media and vacuum. The massfree form of electricity might be called "cold electricity." This hearkens back to another fundamental issue, the very nature of some non-standard biological energies, which are also presumed not to exist and the subject of much mockery these day.

When tracing back the origins of twentieth century conceptions of organisms as purely biochemical systems, with nerve cell electric depolarization as the exclusive explanation for non-chemical, long-range signaling through an organism, one comes to the argument about "vitalism" or "animal electricity" that originated in the scientific controversy between L. Galvani and A. Volta in the late eighteenth century. It turns out that much was lost in the marginalizing of Galvani's "animal electricity" ideas of unipolar (single wire) electric flow by the ascendant bi-polar battery conceptions posed by Volta, which dominate our understanding of electricity today. Some of this debate is beginning to be resurrected and clarified in various new scientific investigations of acupuncture, as an example, using modern medical imaging tools.[6] In the cited study, published in the *Proceedings of the U.S. National Academy of Science* (after its blatant rejection, without review, by mainstream science journals), it is conclusively shown with scientifically blinded examination using ultrasonic and other stimula-

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tion of an acupuncture point in the foot of a subject (many subjects were used): 1) The acupuncture point on the foot, known by acupuncturists to help vision when stimulated, resulted in nearly instantaneous production of activation in the visual cortex of the brain of the subject—a completely reproducible effect that could be toggled off and on; 2) The acupuncture point was found to be highly localized (within a fraction of a millimeter); and 3) The speed of transmission of the information from the foot acupuncture point to the visual cortex of the brain, as measured by fMRI, was at least 1,000 times any known nerve transmission speed. Dr. Joie P. Jones explained, at a public lecture in June 2001 (Society for Scientific Exploration Meeting, LaJolla, California), that because the functional MRI (fMRI) minimum time localization of measurement is about 80-microseconds, the actual transmission speed to the brain might be faster than even this astounding 1,000-fold figure. We shall explore more about these biological energies in future issues of *Infinite Energy*.

For now, an excellent introduction to some of the fundamental issues of bio-energies is provided in the Correa monograph, "Fundamental Measurement of Biological Energies I" (S2-28). They state in that monograph's description of Galvani's seminal experiment with twitching frog legs, "What Galvani had created was an antenna tuned to receive ambipolar electric radiation caused by sparks, and tuned therefore to receive a form of electricity which is indeed different from ordinary massbound electricity, because it is both massless and—phenomenologically—electrically neutral. Galvani had just discovered the existence of Tesla radiation, before Tesla." The historical disaster that has occurred becomes increasingly evident: "What has happened here to Galvani's experiments is exactly what happened a century later, under J.J. Thomson's lead, to Tesla's own discovery of ambipolar electric, longitudinal radiation—it too became reduced to electromagnetism."

It is noteworthy that Tesla was very interested in the electrical component of life-energy, as was that other aether theorist, Lord Kelvin; the two had actually met. Thus, we owe a lot to Tesla, the "Man Out of Time," not only for the technology that runs our world today, but also the future energy sources that will abolish the Hydrocarbon Fuel Age, and for the future biomedicine that will seemlessly integrate Occidental medicine with the wisdom of the East. But first, somehow sanity will have be restored to science on both the physics and biological frontiers. This will be impossible, one fears, without an intense focus on the basics of a restored aether physics. Fortunately, as Tesla, Reich, and now the Correas show, these matters can be adjudicated in laboratory experiment, even as the essentially psychotic scientific establishment—ignorant of the facts of its own history, and only too willing to insult some of its greatest benefactors—ignores it all.

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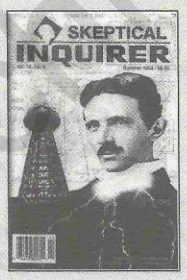
Tesla and the Science Cops

Eugene Mallove



There is nothing better that the science police at CSICOP ("the science cops"—"Committee for the Scientific Investigation of the Claims of the Paranormal") love to hate than what they can only dimly understand. It is therefore not surprising that CSICOP, based in wintery Buffalo, New York (ironically the first city to be electrified by Tesla's technology), would at some point have attacked Nikola Tesla. Sure enough, on our dusty library shelves we find an edition of CSICOP's *Skeptical Inquirer* journal, which devotes its Summer 1994 cover to mockery of Tesla—"The Strange Legacy of Nikola Tesla: 'Extraordinary Science.'"

Author Jeff Johnson—identified as "an electrical engineer and a member of the board of the Rocky Mountain Skeptics"—thinly disguises his brand of Tesla mockery by poking fun at some of the happenings at a meeting in Colorado Springs of what was then the International Tesla Society. He describes this as a gathering of *egotistical* pseudoscientists who were (quoting CSICOP guru Martin Gardner) "motivated by a belief in their own greatness, unrecognized by the world." Johnson claims that in "ordinary" science, "ideas gain stature as unsuccessful attempts to discredit them are made." *Au contraire*, Mr. Johnson, in ordinary science (meaning, Establishment science), no idea that contradicts sacred writ of present textbooks is allowed to have *any* chance to being properly considered—*no matter how unsuccessful the experimental attempts to discredit it are*. New fundamental ideas, such as LENR/cold fusion, are *prima facie* dead on arrival and also thereafter, no matter what proof is offered. It's might makes right all the way.

Johnson can be more direct too. He states that Tesla "later in life was able to indulge in a panoply of bizarre and grandiose ideas; and he achieved considerable scientific notoriety, despite a flawed understanding of physics and other sciences." Note the implied know-it-allness of Mr. Johnson—if *he* were around, boy could he have taught Tesla a thing or two about physics! Moving on to praise Edison's industrial lab style, in contrast to that of Tesla, Johnson writes that "technological development today is too expensive and too complex for any single person to understand it all." Indeed, that misconception about gigantism is why today we have hot fusion and not cold fusion funded officially. It is also why billions of dollars are spent on high energy physics, when simple table-top experiments launched by Tesla can convincingly show that the foundations of such physics are as weak as mud. The arrogant Johnson continues, "A mediocre artist may acquire an exaggerated reputation by dying just before the onset of a dark age, and something similar seems to have happened to Tesla's reputation among unsung geniuses today." Bah!

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A Short Appreciation of Nikola Tesla

P.N. Correa, MSc., Ph.D. and A.N. Correa, HBA

Tesla occupies a fundamental position in the development of our Aether physics and measurement science, Aetherometry, not because he was able to solve any of the basic problems concerning the nature of the Aether, but because he was the first one to pose most of them and to do so with a strictly experimental and systematic methodology. His was the reverse of the Edison approach, where the systematics were a large-scale multifactorial tinkering approach made possible by a large infrastructure with unhindered access to research funding. In Tesla's case, the systematics were singular—an individual life committed to science and interested in all facets of the basic functions of nature. Tesla was led by both a powerful and benevolent intuition. This is what made him so special—and in our eyes produced the force of discovery that led to so many inventions: the discovery of the rotating magnetic field, invention of the induction motor and the polyphase system of alternating current dynamos, alternators and transformers, robotics, radio transmission, wireless resonant ELF power transmission and wireless telephony, teleguidance, electrodeless vacuum lumination, particle beams, magnetic rectifiers, ambient energy capture systems, not to mention his independent discovery of X-rays, his study of disruptive discharges, or his radical improvements on the unipolar dynamo.

For us, there is a still deeper affinity between Tesla's lifelong work and Aetherometry—one that we did not realize existed until we studied the principles behind the resonant operation of his distributed transformer, and still later, when we discovered the principles of operation behind our Aether Motor, which employs the Aether to generate mechanical and electrical power with no conventional power supplies. We often wonder why it took us so long to come to this realization, and the best reason we can come up with is the fact that most of Tesla's work has been so sorely misunderstood, even by very well-intentioned people. Our own understanding had remained prisoner of these same bounds. Since Tesla's work can so easily be plundered and inappropriately plucked, it became subject to every pundit's whim. Mechanistic science reduced it to neo-Maxwellian electromagnetism; ZPE theorists "rediscovered" it in the supposed use of the magnifying transformer as an "electromagnetic cannon"; engineers reduced the resonant Tesla coil to an RF emitter or (to borrow the Corums' phraseology), in the best of cases, to "lossless tuned lumped coupled coils"; addicts of special effects fantasized about the megavoltage of gigantic sparks; and plenty of apocryphal stories abound concerning his Aether-propelled automobile that is said to have traveled back and forth to Niagara Falls. The mythology undoubtedly hurt Tesla's standing—and his inarticulate opposition to Relativity did not help, anymore than his incorrect computation of superluminal propagation for Tesla waves, or his belief in P. Lowell's Martian "canals" or his claims to have received radio communications from outer space. Tesla was in dire need of a novel physico-mathematical approach to the energetic analysis of the Tesla radiation he had discovered. We believe our experiments and theory have accomplished this.

Yet, Tesla was only too keenly aware that his resonant transformer (USPTO Patent #433,702, August 5, 1890) could operate in either of two very distinct modes, which he thought were fundamentally frequency-dependent (low-frequency reducing the energy dissipation by what he called "electromagnetic waves"): the production of "electromagnetic waves"—as seen in most antennas due to their large capacity and small self-inductance—versus production of what he called "ground conduction currents" or "conduction energy" employing resonant principles of transformation, transmission and "active reception." Essentially, what he was trying to get at were the principles of propagation of what we call *ambipolar radiation* under resonant conditions that minimize local generation of photons ("no electromagnetic radiation," in Tesla's words), even if he anticipated this could only be done through the ground or the ionosphere.

This matter became clear to us solely with the development of Aetherometry—with our discovery of the physical principles behind the indirect production of blackbody photons from ambipolar radiation, and the operation of Tesla coils to magnify *massfree* radiation in excess of the *massbound* electric power they consume. It is amazing to realize that Tesla coils can indeed be shown to be examples of "over-unity" devices, when the *massbound* and *massfree* flows are properly accounted for. The basic demonstration of these stunning facts was carried out in our published AS2-13 to AS2-17 monographs (available at www.aetherometry.com), where novel (aetherometric) experimental and theoretical tools were employed to differentiate, on the basis of fundamental physical effects, the ambipolar massfree radiation of Tesla waves from the radiative effects of photons—whether ionizing, HFOT (high-frequency optothermal) or LFOT (low frequency optothermal) photons—as well as from the monopolar electric field effects of ion fluxes or electrostatic charges. These reports established, from basic scientific facts, the existence of a longitudinal, massfree, electric ambipolar form of energy radiation, which is emitted from these coils, and *is distinct from electromagnetic energy*. They also provided a novel way to ascertain the electric wavespeed of the ambipolar radiation, known as Tesla waves, and formally demonstrated how it is not bound by the speed of light, c, and typically exceeds it.

By the time we were attempting to replicate and decode Wilhelm Reich's experiments detailed in his Oranur Report (1951), and in particular to rediscover the principles of his OR (orgone) Motor, we came to the further realization that, in fact, Tesla had been the originator of the idea, but that his implementations had suffered from

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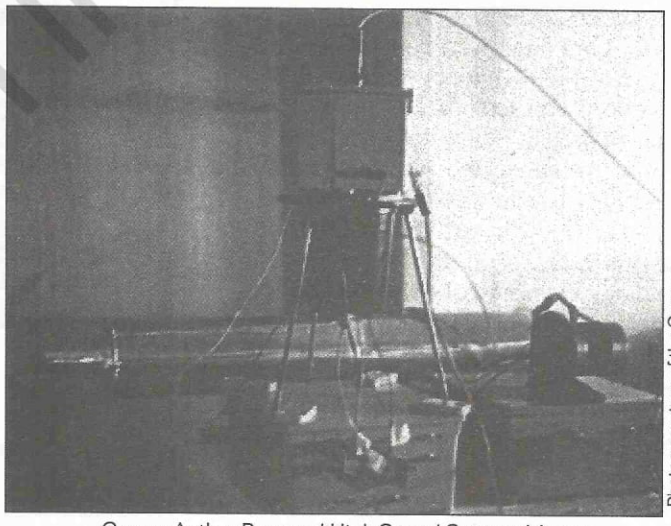
many set-backs. The result was that Tesla never actually succeeded in creating a functional Aether Motor. If, in his later life, he managed to do so, he certainly left behind no written record of the matter—unless evidence is one day found for any of the apocryphal Tesla stories of the first Aether-powered Autonomous Electric Vehicle (AEV), as we call it. On the contrary, Reich's genius lay precisely in overcoming many of the limitations that had precluded Tesla from realizing his dream of directly tapping Aether power from the fabric of Space and Time. Eventually, we came to realize how much Reich's discovery was owed to Tesla.

Lastly, there is the connection that Dr. Mallove has emphasized in his editorial in this issue: the link between ambipolar energy and a new biophysics of biological systems and the chemical functions of biological molecules. It is a subject too long to elaborate here, but one that will be shown in the years to come to owe much to both Tesla and Reich, their insights and studies. One might say that its point of origin was utilitarian: to counter Edison's assertion that alternating currents could only be employed for deadly purposes, Tesla demonstrated that thousands of volts could be passed with no harm through his own body at high frequency. But this foreshadowed the novel biophysics of ambipolar radiation which Aetherometry has brought forth and made possible: the complex dynamics of massfree energy, electric and non-electric, in living systems.

We could comment on Tesla's politics—his desire to abolish war and eliminate misery, contribute to a global and enlightened society, develop a better humanity, and retain what one could call a puritanical morality. This would also take us far afield, but just to summarize: We do not doubt that Western civilization is the work of the Judeo-Christian State, and that technocratic capitalism is its ultimate embodiment. But, like Reich, we cannot disregard the prevalent libidinal and emotional dysfunctionality of human beings—which is so often seen in scientific controversies as an example, the perversity that accompanies puritanical moralism, the lies of an international State, the erasure of individual liberties in the name of a nonexistent "Humanity"—after all, isn't each individual already a collectivity?—and, at the end of the day, the sheer necessity for combat that Life is confronted with if it is to create and reinvent itself beyond present day mores and conventions.

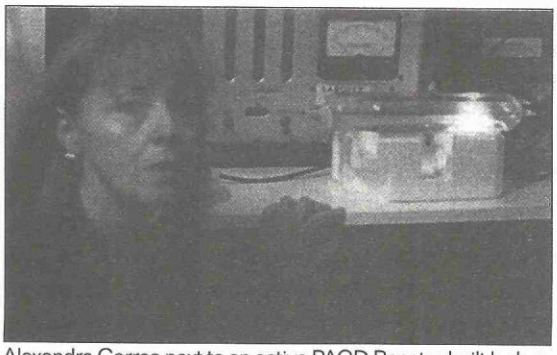
Science and technology can never dictate either a better or worse course of action. When all is said and done, even education and knowledge by themselves would not suffice. For all the critical choices we make are, at bottom, choices of desire, political and libidinal choices, that, for sure, need to be better formed and informed. These are made between regimes of a large number of people (molar groupings) and regimes of individuality or singularity (molecular groupings). In his analytical investigations, the philosopher and physician F. Guattari (1930-1992) spoke, in this respect, of the logic of *subjected* groups versus the logic of *subject-groups*, and their inevitable and constant combat. But this perspective, too, has been dissolved by the current acid of the "politically correct," with the vague notion of "empowerment" that leads simply to a more oppressive weight of ideals, but to no real tools for change.

Of greater importance to us—and of greater urgency for those who desire to know better how Nature really works—is that a new unitarian approach to physical and biological systems is demanded if science is to understand the nexus of the fundamental inventions and discoveries of Tesla. In fact, classical tools, like those which Steinmetz developed, are not sufficient to understand high-frequency alternating currents; and no amount of Quantum Electrodynamics is going to correct the mistakes that have gone under the bridge and have become rigid dogma. One would have to follow in the footsteps of Reich's late approach, and well beyond it, to discover that there are two distinct manifestations of electricity, *massbound* and *massfree*, or, monopolar versus ambipolar. Electrons are massbound, and these comprise the only kind of electricity that is generally accepted today. Ambipolar charges (within ambipolar radiation, *i.e.* Tesla waves) are massfree, and should become a dominant form of electricity in the future. The incomplete understanding of electricity today gives us a measure of how out-of-Time Tesla was with his empirical discoveries, and how slow indeed is the measure of progress in scientific understanding and the benevolent usages of technology.



Photos courtesy of the Correas.

Correa Aether-Powered High-Speed Spinner Motor



Alexandra Correa next to an active PAGD Reactor built by her.

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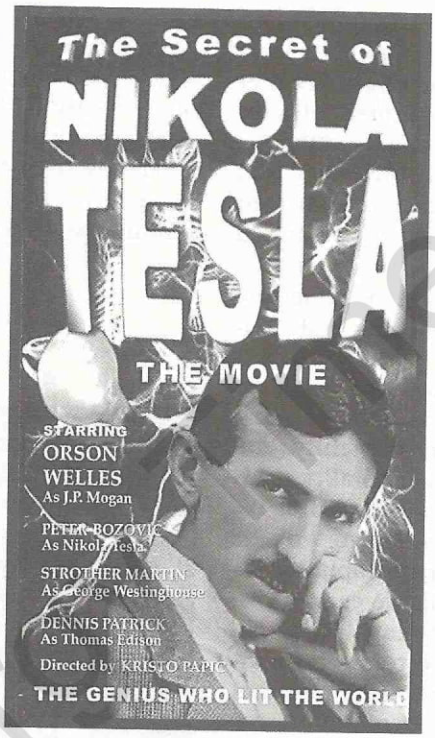
Video Review:

"The Secret of Nikola Tesla"

Ken Rauen



"The Secret of Nikola Tesla" is a warm-hearted surprise. It does not contain any secrets about the fantastic science and technology of that mysterious man, but it does portray the life of the person, about whom history has said so little. The movie does contain moments of technical pizzazz, including a few scenes in his New York City laboratory, probably filmed with actual working devices; the bluish-white arcs blazing across the room from large Tesla coils were probably real. The outdoor effects in the European and Colorado Springs scenes were definitely Hollywood creations.

The value of the movie is in the people it portrays. Not only the persona of Nikola, but the people who were around him, and the portrayal of many events which shaped history. The person who first saw Nikola for the exceptional person he was was Katherine Johnson, the wife of the Editor of *Century* magazine. She fondly called Tesla "Nicky," and she brought out the best human side of him. George Westinghouse came close to being Nikola's best friend and admirer, calling him "Nick." George was a magnanimous man, being the first one to trust and support Tesla in his work. Tesla was in many ways too serious, generally lacking normal social skills; he was an introvert, without a doubt. Compared to his contemporary and peer, Thomas Edison, Tesla was a gentleman. Edison is depicted as a grouchy, arrogant, and egotistical man, consistent with the character portrayed in Margaret Cheney's book, *Tesla: Man Out of Time*. The movie brings out this distinction very clearly, and it makes the viewer keenly aware why the two famous inventors did not get along.

The acting is superb and very entertaining. The presence of Orson Welles as J.P. Morgan, Tesla's second financial supporter, enriches the characterizations very enjoyably. It also is clear why Morgan abruptly halted the funding for Wardenclyffe (which, by the way, is depicted in the historically accurate rural, agrarian environment of Long Island in the early 1900s). Morgan saw Tesla's dreams of transmitting electromagnetic power (not just radio signals like his contemporary, Marconi, who also appears in the movie) as threatening to his love of earning lots of money. Morgan only supported Tesla as a game; he was amused by Tesla. Thomas Edison, the competitor of Tesla, was Morgan's regular card playing, whiskey drinking buddy.

The movie reveals Nikola's personal preferences, such as his health fetishes with clean silverware and other things, his strong bond with his mother (who nurtured his dreamy side as a child), his attitude about women, and his deeply entrenched ethics. Thomas Edison was known to oppose alternating current, steadfastly championing direct current. Edison showed his cunning cruelty and unconscionable business ethics when he electrocuted dogs in public with AC to illustrate the supposed superiority of DC power. Tesla found a way to rebut him, and the movie holds a suspenseful surprise for the viewer; it also is a techno-thriller of a scene! Tesla was honest, but knew how to play games, and his playfulness showed. His humor came through at many times.

Embellishments abound, such as the appearance of Mark Twain with his indomitable wit. Twain was a good friend of Tesla's, and with Twain's humor and strident personality, you could see another facet of the secretive Nikola Tesla, which this movie portrays as well or better than the intimate books written about the man who arguably is the greatest inventor in modern history.

For the science buff, this is a fabulous entertainer. Just plain good fun, with a theatrical dose of history! ❑❑❑

— Video available from *Infinite Energy*, at www.infinite-energy.com —

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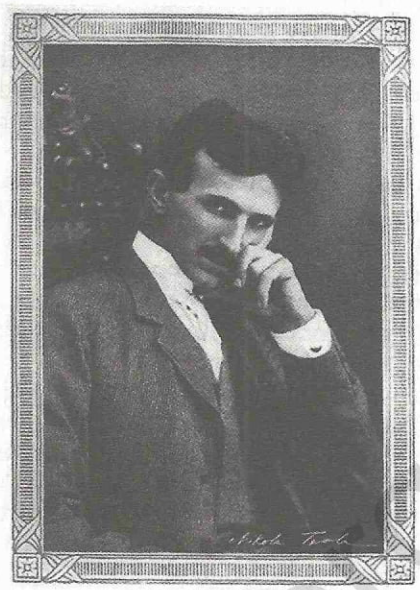
Tesla the Man: Commentary on His Life

Soo Seddon



Tesla on the cover of the *Electrical Experimenter*, 1917.

When Jeff Kooistra first reviewed *Wizard: The Life and Times of Nikola Tesla* for *Infinite Energy* #12, he said he was "a veteran of several Tesla reviews." After plodding through no less than three biographies of electricity's greatest showman, I confess to feeling somewhat battle fatigued.

Unless you are a total Tesla freak, don't, I repeat, *don't* try this at home.

My entree was *Prodigal Genius* by John J. O'Neill [Reprinted 1968, Spearman, ISBN 6-81610-1]. This was a good choice as starter. I chose it mainly because O'Neill was a close friend of Tesla and claimed to know him better than anyone.

This book is the definitive biography and one from which the other authors clearly lifted much of their material on Tesla's personal life and eccentricities. It is heavily, and quite unashamedly, biased in favor of reflecting only the positive aspects of Tesla's character. O'Neill has a tendency to gloss over the inventor's mistakes and misjudgments, focusing only on his achievements and his incredible insight into technologies, the realization of which still lay far ahead in the future.

I could probably have written the above paragraph based merely on reading the author's preface. O'Neill writes: "The rising star of Tesla's genius shot across the electrical heavens like a meteor."

Such shining phrases, however, are not unusual in books about Tesla. My main course, *Tesla: Man Out of Time* by Margaret Cheney [1981, Prentice-Hall, ISBN 0-13-906859-7], had a few liberally sprinkled here and there. The man clearly inspires such rhetoric in his admirers and Cheney *is* a long-standing member of the Tesla Memorial Society.

Her book was more of an in-depth, historical biography, which examined his accomplishments a little more closely and didn't concentrate so heavily on his personal traits.

As a big fan of desserts, I found *Wizard: The Life and Times of Nikola Tesla* by Marc J. Seifer [1998, Citadel Press, ISBN 1-8065-1960-6] to be as appetizingly interesting as a mountain of profiteroles [puff pastry filled with whipped cream] drenched in hot chocolate sauce.

Seifer's book is a factual, academic biography and a very fair account and assessment of Tesla's life and works. And, like all good desserts, it weighs a lot.

In all three books, the unembroidered story is basically the same.

Tesla's Story

Nikola Tesla, born in Croatia in 1856, shunned the family tradition of entering the priesthood and longed to become an engineer. Not an easy choice of profession for a sickly, weak young man who suffered heart flutters, twitches, and a profound sensitivity to bright light. For long intervals

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throughout his life, Tesla was bedridden and frequently believed to be at death's door.

Tesla's career as an experimenter began at an early age. As a schoolboy he invented a smooth waterwheel, a design he adapted many years later to produce his bladeless turbine. It is not known whether his propeller, powered by harnessed May bugs, ever found any future application.

Following the death of his much-favored brother, Dane, Tesla felt the need to excel in order to gain his parents' affections. The frequency with which he was unfavorably compared with his late brother left him with a low self-esteem and lack of confidence which persisted throughout his life.

He used his natural flair for invention to obtain love and admiration, firstly from his parents and later from society as a whole.

He fiercely resisted complying with his parents' wish that he join the priesthood, telling his father: "It is not humans that I love, but humanity."

Tesla eventually won the freedom to study engineering in Graz, Austria. His stubborn streak manifested itself early in his academic career when, following a bitter argument with his professor on the supremacy of AC power over the standard DC system of the time, he pledged himself to proving his lecturer—and the rest of the world—wrong.

In 1882, Tesla worked for Continental Edison in Paris; when he emigrated to the U.S. two years later, a good reference from his former boss assured him a job with the parent company, where he undertook to improve Edison's dynamo design.

Edison, the innovations wizard of the day, astounded Tesla, who believed his achievements were nothing short of miraculous given his rough and ready experimental technique. Tesla worked in a very scientific fashion and regarded Edison as a hit and miss tinkerer. There was a degree of snobbery also, as Edison had not had the benefit of a good education as Tesla did.

Edison promised Tesla $50,000 at the end of the dynamo project, but ultimately reneged on the promise. Tesla was furious and resigned on the spot.

He later worked with several would-be benefactors, improving their systems in the hope that they would, in turn, sponsor his ambitious AC project. Two New Jersey businessmen, Vail and Lane, utilized Tesla's skills to improve their lighting manufacturing processes, and then refused to sponsor his AC research. He was forced to leave and spent the hardest year of his life working as a laborer, totally bankrupt.

But Tesla crawled back, as he was wont to do. His foreman on the digging site took an interest and introduced him to new potential backers. Tesla impressed them and began work on his AC process, completing several multi-phase systems along with all the back-up machinery and theoretical notes on all. Tesla almost overworked himself to death on these projects. George Westinghouse bought many of the AC patents and supported Tesla's research.

One highly publicized event almost left AC power research dead in the water. Alternating current was used in a public execution to power the electric chair. The prisoner was not properly prepared and the results were horrendous. Tesla's detractors used the incident to full effect in denouncing AC as not even death row-friendly.

Tesla retaliated, in typically spectacular fashion, by staging a demo, where tens of thousands of volts were passed through his body, enabling him to illuminate lighting tubes and, as the sparks were still shooting from his fingertips, he enquired, "What killer current?"

Flowery acclaim almost inevitably followed such demonstrations. One observer reported that "exhausted light tubes held in the hands of Mr. Tesla appeared like a luminous sword in the hand of an archangel representing justice."

Tesla, in time, became a cause celebre amongst New York's chattering classes. There are many bizarre chapters in all three biographies relating to his association with the socialite Johnsons. Mrs. Johnson, particularly, appeared totally enamored of the Croation engineer. His natural shyness drew her to him like a magnet and she wrote him long letters in which her obvious attraction to him was veiled in very odd terminology indeed. Clearly she didn't even break the surface when it came to understanding Tesla the man.

She was undoubtedly charmed by his charismatic public performances—what a dinner party coup it must have been to have the man everyone was talking about as an impressive dinner guest. Tesla was always attentive and polite, but he shunned society as far as he possibly could. Being expected to perform for Mrs. Johnson and her set must have been torture for him.

Tesla was eventually honored in his own country. He returned briefly to attend to his dying mother and was greeted like a megastar. Honors were poured upon him. He eventually, however, took U.S. citizenship.

The great AC versus DC battle continued to rage. The establishment, geared at great expense towards DC, closed ranks against Tesla and his rantings.

George Westinghouse and Edison were locked in a "battle of the currents" and Tesla nobly sacrificed the huge royalties he stood to get from his AC motors in order to help Westinghouse stay afloat financially.

Tesla began work on his most ambitious project ever in 1900—his Wardenclyffe Tower, built on Long Island. Financier J. Pierpont Morgan initially sponsored this research, believing it to be a huge radio mast. Tesla, however, had other ideas. The tower would be a base station for the transmission of power and information across the world and would, Tesla believed, eventually supply free energy to any point on the globe. When Morgan discovered the real purpose of the tower, he backed out of the deal and left Tesla struggling for almost five years to complete the project. It was never completed and eventually Tesla had to sell the site to repay his debts.

Nikola Tesla died in 1943, penniless and living on credit, at the Waldorf Hotel. The FBI was quick to confiscate all his papers—rumors abounded, and still do, that Tesla had invented several deadly weapons. The papers were eventually released, many years later, to a relative.

Tesla's Personality

An examination of Tesla's personality traits warrants an entire book on its own. Sigmund Freud, born in the same year, would have had a field day.

According to J.J. O'Neill's biography, Tesla "engineered women out of his life." The bachelor scientist was always immaculately dressed and was, reportedly, totally charming to all the females he encountered.

He was an obsessive workaholic who suffered several nervous collapses due to exhaustion. Even when he wasn't

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working, his mind seldom switched off. He had a photographic memory and, more unusually, he had the ability to mentally visualize his designs and inspect them in a kind of holographic 3D. Many of his inventions were never committed to paper throughout their development.

The down side of his mental hyperactivity was violent migraines, disturbed vision, and frequent light flashes. He was obsessive about germs and had many obsessive compulsive routines designed to thwart them. He would use dozens of clean towels when bathing in order to reduce contamination.

The number three was a pet fixation. He would only stay in hotel rooms numbered three or multiples of it. Earrings and pearl jewelry of any kind repulsed him.

Towards the end of his life he acquired a passion for cultivating the friendship of the city pigeons. His hotel room was frequently filled with or surrounded by them.

For all his reported charm, Tesla was basically gauche with few social skills. He would have been much wealthier had it not been for these handicaps. He had dreadful difficulties in selling his ideas to investors, something he badly needed to do, as almost all of his ideas were way in excess of his own resources. Tesla was also fickle in the way he flitted between one project and another, rarely completing most of them.

He claimed to regularly experience out of body episodes, during which he "travelled" widely. Yet, this oddball was clearly a genius whose fundamental researches paved the way for many inventions now taken for granted. His idea for global transmission of information alone was inspirational and way ahead of its time.

It is widely considered that his futuristic postulations led to developments in many fields: satellite technology, microwaves, beam weapons, nuclear fusion, robotics, the internet, geophysics, solar power, oscillation experiments, VTOL craft, radar, and even cryogenics—one of his patents refers to a gaseous cooling agent.

Tesla was not, however, credited with many of his actual achievements, such as fluorescent lighting, bladeless turbines, X-rays, or radio. The eternal experimenter definitely didn't suffer from the notorious "inventor's disease." After the demolition of his beloved Wardenclyffe Tower, Tesla said:

> Perhaps it was better that a revolutionary idea or invention be hampered and ill-treated in its adolescence by want of means, self interest, stupidity and ignorance, so that all that was great in the past was ridiculed, condemned and suppressed only to emerge all the more powerful, all the more triumphant from the struggle.

Some of Tesla's notes tantalizingly refer to a new source of free energy. No details are given, other than the process was not nuclear and would require a great deal of steel!

Tesla and Cold Fusion

How, I wonder, would Tesla view cold fusion research. It would definitely give him a strong feeling of *deja vu* to discover essential progress is still being hampered and thwarted by vested interests and that there is still the desperation to maintain an outdated and inefficient status quo.

The huge financial investment in perpetuating current energy infrastructure and practice is still every bit as obstructive to a cold fusion-powered world as it was to Tesla's attempts to convert a DC-powered one. ❑❑❑

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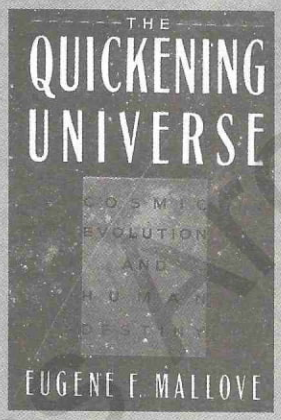

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New Horizons in Lighting

Jon Norris*

When looking at energy efficiency as a source of "new energy," one must eventually turn to the subject of lighting. While not the major portion of our energy use, lighting still uses a significant amount of electric power. Even a relatively modest savings could be significant.

Most people are by now aware of compact fluorescent (CF) bulbs and the energy savings that can be seen by switching to them from incandescent (IN) bulbs. (CF bulbs were discussed in Samuel Case's article, "Energy Innovations: An Overview," in *IE* #41.) They can save approximately two-thirds on lighting energy use. However, there are even better lighting technologies on the horizon. The one most likely to affect users in the near term is Light Emitting Diodes (LEDs).

LEDs are semiconductors similar to solid state diodes, except they are optimized to emit light. They are related to laser diodes. We have seen these cute little beasties in our electronic equipment and toys for quite awhile [Editor's Note: See the Infinite Light Flashlight ad, p. 1], but recently researchers have begun to get serious about using them as light sources as well as indicators. Significant progress has been made in the last few years toward creating LEDs in colors other than red, green, and yellow. We now have blue, orange and, most important, white. Now the focus of research is to create brighter LEDs at lower cost. There are already LED devices on the market to replace other types of bulbs, but the purchase cost is still extremely high by comparison.

LEDs offer many advantages over IN and CF bulbs. First, being solid state, they are far more durable and safer than bulbs with glass envelopes. They are also smaller and emit far less heat. Being DC devices, they can be easily run off low voltage (12V or lower) DC circuits, making them ideal for marine and RV applications. They have an extremely long life compared to the other light sources. They have already begun to revolutionize the flashlight market, and are moving into auto lighting and signage. They can easily be used in spot and task lighting, as well as in distributed and decorative lighting.

One very important characteristic is their extreme efficiency. We are quite happy with CF's two-thirds energy savings, but LEDs offer far more. They can be as much as ten times more efficient than IN bulbs. One current commercial LED device I have seen replaces a 150 watt flood light with a 144 LED cluster that uses about 12 watts. The big drawback is that it costs $700 to the IN bulb's $6. The lifespan of LEDs is usually stated to be about 100,000 hours of use, which is about eleven years of 24-hour-a-day use. The life of the IN bulb in this comparison is 2,000 hours, which means you will replace quite a number of them to equal one LED device. I worked out a simple test scenario, never expecting the LED to come out in any kind of reasonable position, given its high cost. I was surprised at the outcome, to say the least.

Since devices seldom perform their entire useful life, I felt one-half useful life would be a good target for comparison. For the LED device, this would be 50,000 hours. At 12 watts, it would use 600 kWh over the life of the test. Figuring $.086 (8.6 cents) per kWh for comparison purposes, I came up with a figure of $51.60 for energy use for the test. Combined with the $700 cost of the device, it came in at $751.60 total cost.

With the IN bulb, I used a 1,000 hour life (half of the rated life). This would mean that I would need 50 such bulbs to cover the 50,000 hours life of the test. At $6 per bulb, that comes to $300. Hmm, the LED is starting to look better. The real kicker is in energy use. At 150 watts, the IN bulbs will use 7,500 kWh over the life of the test. At our test rate of 8.6 cents per kWh, that comes to $645, for an IN case total of $945! The LED could actually be a better deal,

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even at current prices! I was shocked when I first did this comparison, so I repeated it and had others check my figures. The LED device saves nearly $200 in energy costs in my test scenario! At higher energy rates, and given that the LED device may well exceed the 50,000 hour mark, it can only get better. It pays to look at the long-term picture in energy use. (This scenario also does not include the cost of disposal of the 50 IN bulbs.)

Many have already seen the advantages of LED lighting and are beginning to utilize them. Over one half of the red stoplights in the U.S. have already been replaced with LEDs, and replacing all such signal lights will result in considerable energy savings. Railroad crossing warning lights and other such applications are also being changed. LED lighting is a technology well worth a serious look even now.

Another alternative method of lighting employs fiber optics. While fiber optics still use incandescent bulbs as the light source, there are some advantages to using them. The usual design is to house the light source, which is made up of one or more halogen projection bulbs, in a central location and run fiber optic cables to the various places one wishes to light. This allows the electrical wiring to be kept to a minimum, as fiber optics are non-electricity carrying and safer to have in many locations in a building. It is even possible to safely use fiber optics underwater, as in a fish tank, hot tub, or swimming pool. While the projection bulbs do create a tremendous amount of waste heat, having it all in one location makes it easier to manage and use constructively, such as supplementing the building's heating source. Servicing the bulbs is also much easier. Different fixtures are available for dispersing the light at the end of the fiber optic cable where it is used. The energy savings are not all that great, but the safety and flexibility of fiber optics makes them a lighting technology worth considering.

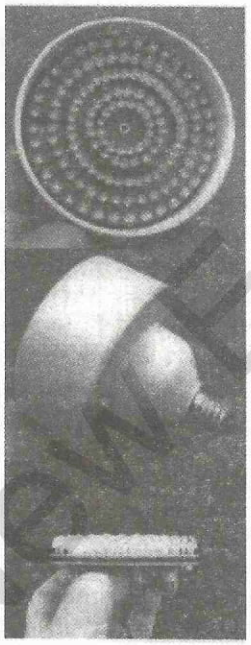

Photo courtesy of www.theledlight.com.

A 144 LED medium base floodlight bulb.

Passive solar lighting has always been around in the form of windows and skylights, but now there are several companies offering a variation. Called "sun tubes" or "sun pipes," these are basically a mirror-polished tube of some sort that reflects light down from a collecting device on the roof. The light is dispersed by a fixture at the bottom of the tube, which can be modified depending on the lighting requirements. The diameter of the tubes varies from 8 inches to over 14 inches, and the length of the tubes can be varied depending on the requirements of the building where the tubes are installed. The energy savings here are huge, with the average 12 to 13 inch tubes giving off the light equivalent of a 100 watt incandescent bulb on a cloudy day. On a sunny day, the amount of light can be ten times that much, according to the manufacturers. While these tubes do share one of the drawbacks of skylights—cutting a hole in one's roof—they diffuse the light so that the bleaching effect of direct sunlight is avoided. These fixtures allow the use of passive solar lighting in areas where windows or skylights are impractical or impossible. The use of passive solar energy means there is no ongoing energy cost, although they obviously do not work at night, thus requiring some form of supplementary lighting.

I have seen a Japanese variation on this design that mixes fiber optics with the sun tube idea, but do not know if it is readily available, or what the cost would be. The regular sun tubes start at about $200 and go up, depending on size and number of extension tubes needed to bring the light to the desired area. This is about the cost of a simple dining room fixture, and the energy savings in the long run could be significant. Using an example similar to the LED situation above, a 100 watt bulb burning for eight hours a day uses 292 kWh a year, so one could save about $25 a year per fixture, at our 8.6 cents/kWh rate. In a sunny locale, the savings could be even greater.

While these theoretical comparisons obviously cannot guarantee the exact savings shown, these new lighting technologies are well worth investigating in the search for efficient use of energy. □□□

About the Author

Jon Norris is a twenty-seven year veteran of the telecommunications industry. He began his study of anomalous data and fringe science in the late 1960s after exposure to John Campbell's editorials in *Analog*. He is currently the team leader of a teleproduction facility at a small university. Mr. Norris continues to comb the fringes of science for valuable information.

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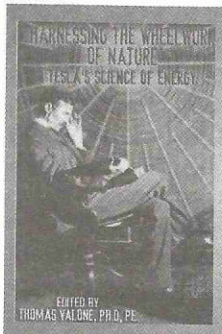
Book Reviews



Harnessing the Wheelwork of Nature: Tesla's Science of Energy

by Thomas Valone, ed.
ISBN 1-931882-04-5
$16.95 Paperback, 338 pp.
Adventures Unlimited Press, 2002

Press release review by Integrity Research Institute

Harnessing the Wheelwork of Nature is a new book by Thomas Valone, who edited it in time for the Wardenclyffe Tower Centennial (1903-2003). Valone's book presents, for the first time, the feasibility argument for Tesla's most ambitious dream, the wireless transmission of power. Pictured on the book's cover near Tesla's feet, the 187-foot Wardenclyffe Tower was part of his plan to deliver natural 8-Hz electricity anywhere in the world, by longitudinal waves.

Unknown to most electrical engineers, Nikola Tesla's dream answers the energy crisis worldwide, saves electrical conversion losses, and provides a real alternative to transmission lines. In Dr. James Corum's contributed papers, he explains Tesla's "magnifying transmitter," which Tesla compared to a telescope. Corum points out that "the tuned circuit of his magnifying transmitter was the whole Earth-ionosphere cavity resonator." This helps explain why Tesla wrote, "When there is no receiver there is no energy consumption anywhere. When the receiver is put on, it draws power. That is the exact opposite of the Hertz-wave system. . .radiating all the time whether the energy is received or not." Thus, with Tesla's futuristic transmission of power, source dissipation will only be experienced when a load is engaged in a tuned receiver somewhere on the earth. This fact alone represents a major leap forward in electrical transmission efficiency, even one hundred years later.

Dr. Elizabeth Rauscher indicates in her paper that the Earth's magnetosphere is the source of electrical energy, as Tesla emphasized. She points out that the relatively small longitudinal impulses that the Tesla Tower supplies triggers the Earth-ionosphere oscillations to take place so the receivers can tap the Earth's atmospheric electrical energy. Tesla estimated the available energy of the Earth-ionosphere cavity at 7.5 gigawatts, whereas Dr. Rauscher today shows that it is closer to 3 terawatts (3 billion kW), while the U.S. only consumes an average of 360 million kW today for electrical needs (at 27% of the world usage). Therefore, the Earth has almost three times the capacity available for electrical consumption than the entire world presently utilizes every day.

Why wasn't the prototype of Wardenclyffe finished in 1903? Tesla offered this visionary conclusion: "The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success. . .Let the future tell the truth and evaluate each on according to their work and accomplishments. The present is theirs; the future, for which I really worked, is mine."

Up until now, there has been a general malaise in the scientific comprehension of Tesla's greatest dream. For example, the Serb National Federation notes, "With the exception of the first biography of Tesla by John J. O'Neill, science editor of the *New York Herald Tribune*, and published in 1944, unfortunately no biographer since has had the necessary scientific/engineering academic credentials to discuss Tesla's work in the various fields." Contributors to *Harnessing the Wheelwork of Nature* are primarily physicists and engineers who are experts in Tesla technology. Their wealth of knowledge demonstrates their mastery of this extraordinarily progressive and technical subject. Finally, the best academic credentials have been brought to bear on the world's greatest electrical futurist.

This is a very readable and profusely illustrated reference volume on wireless transmission of power, besides being a biographical goldmine of Tesla history. Nick Cook, editor of *Jane's Defence Weekly* and author of *The Hunt for Zero Point*, says: "Tesla is one of the great overlooked geniuses of science and electricity. His full story deserves to be told. Tom Valone sheds important new light on his life and work." [*Harnessing the Wheelwork of Nature* is available from *Infinite Energy*. See the ad on p. 35 for more information.]

Cold Fusion: A Modern Story of Inquisition and Alchemy

(in Italian)

by Roberto Germano
Paperback, 193 pp.
Bibliopolis, 2002

Review by Peter Glück

Roberto Germano finished writing this book near the tenth anniversary of cold fusion (1999). Reading this work more than three years later, a question arises: Has the author correctly anticipated the short-term future development of this scientific field? I believe he has. The book concludes with a Zen-like "koan" told by cold fusion theorist Emilio del Giudice, which suggests that for awhile the "search" will be more prominent than actually reaching the final goal. In other words, cold fusion will have a rather long history before it comes to fruition.

The book is a very creative mixture of a cultural history of the problem of new science, with a genuinely Italian view of cold fusion, and of a tutorial/reference book with comprehensive lists of papers and patents. But, most of all it is the personal history of a young, smart, and honest scientist who discovered the truth regarding cold fusion in 1995 and, confronting inquisition, bravely supported the truth.

The foreword was written by the late leading personality of cold fusion, physicist Giuliano Preparata, a human flame so prematurely extinguished, whose dynamic concepts regarding the structure of condensed matter continue to inspire many

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scientists—including those at the Frascati lab in Italy.

The first chapter describes and explains the relationship between theory and experiment, in an historical and cultural context—with many examples from the dark Middle Ages—which sometimes seem to continue today, in new forms, but essentially unchanged.

Next we are introduced to the moment when Germano discovers cold fusion and has a kind of intellectual "satori." He continues by telling us about his personal view of the cold fusion saga: birth and infancy, a zoo of experiments illustrating the very richness of the field, and a more detailed description of the possible reactions. Another chapter is dedicated to low-energy nuclear reactions, the "alchemy of the year 2000." The next part, "CETI Inc., Commercial Cold Fusion," is unfortunately the story of a huge opportunity lost, due to reasons that remain largely unknown.

An entire chapter, "Quantum Electrodynamics: Italy in the Vanguard of the Cold Fusion Theory," describes both the basics of this important theory and the story of the oppression exercised by the scientific inquisition toward the authors of this theory, who are Giuliano Preparata, Emilio del Giudice, and Tullio Bressani.

Their theory suggests that cold fusion is a *coherent* phenomenon and is an essential part of the new paradigm that will change the future of physics, biology, and much else. Germano speaks about possible futures in the last "core" chapter of his book. He deeply understands the inherent complexities of low-energy nuclear phenomena. His prediction is realistic, but exactly what the future will hold is unknown. The colleagues and friends of the author are doing a wonderful job; Italy will no doubt have an immense contribution to the inevitable victory.

Three useful appendices add to the value of the book. The problems of electrolysis and those of hot fusion are well described and a list of patents and updates of the cold fusion papers will help the reader obtain a good and comprehensive vision of a new scientific discipline.

It is known that Italian is a beautiful, vivid, and elegant language, of which the author is a great master. It was an enchanting experience to read this account. It is my hope that we will read a second cold fusion book written by Roberto Germano, the story of a scientific and technological triumph. ❐❐❐

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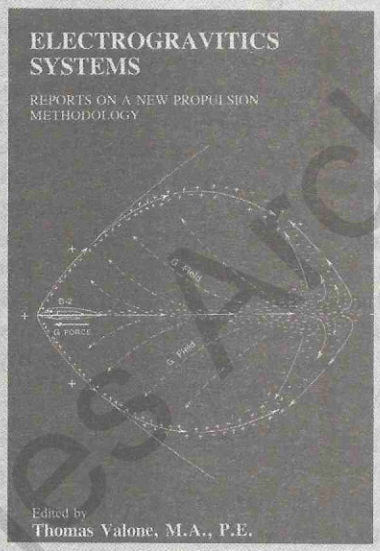

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ECLECTIC OBSERVER

Compiled by Eugene Mallove

Rising World Energy Use

The Organization for Economic Cooperation and Development (OECD) is a consortium of countries that publishes large volumes of statistics and economic reports, of use to its member nations and others. The thirty member nations listed on its recent newsletter include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the U.S. The "OECD in Washington" newsletter (No. 39, December 2002) had this to say about rising world energy use. It is a bleak picture:

> The *World Energy Outlook 2002* (ISBN: 9264-19835-0, $150.00, OECD/IEA, Paris, 2002) predicts a future in which energy use continues to grow inexorably, fossil fuels continue to dominate the energy mix, and developing countries fast approach OECD countries as the largest consumers of commercial energy.
>
> • Fossil fuels will remain the primary sources of energy, accounting for more than 90% of the increase in demand.
>
> • Almost 75% of the increase in demand will come from the transport sector.
>
> • More than 60% of the increase in energy demand will continue from developing countries, especially in Asia.
>
> • Global crude oil refining capacity is projected to increase by an average 1.3% in 2030 with over 80% of new refining capacity built outside the OECD.
>
> • Nuclear energy production will peak at the end of this decade, then decline gradually as its share of world primary energy demand falls from 7% in 2010 to 5% by 2030.
>
> • Carbon-dioxide emissions will increase by 1.8% per year from 2000 to 2030 reaching 38 billion tons in 2030, 70% more than today
>
> The Earth's energy resources are undoubtedly adequate to meet rising demand for at least the next three decades. But the projections in the *World Energy Outlook* raise serious concerns about the security of energy supplies, investment in energy infrastructure, the threat of environmental damage caused by energy production and use, and unequal access of the world's population to modern energy.

The scenario painted by OECD, of course, does not even hint that some kind of new energy source might emerge to disturb its projections. Let us hope that diligent research and development in new energy will prove the OECD figures to be thoroughly wrong.

Hot Fusion Money Heist Succeeds, "Tokamak Mafia" Wins Big

In last issue's "Eclectic Observer," our new energy "detectives" reported that a "Hot Fusion Money Heist" was afoot—that the U.S. hot fusion community was orchestrating another major looting of the U.S. Treasury, as it tried to persuade the Congress and the Bush Administration to rejoin the infamous $10 billion (now a trimmed-down $5 billion) ITER (International Thermonuclear Experimental Reactor) program. It has just succeeded beyond its dreams. The hot fusioneers' back-up plan was to push for something called "FIRE"—"Fusion Ignition Research Experiment," a U.S.-based tokamak (magnetic confinement fusion) plan, but now this will not be needed.

On January 30, 2003, following President Bush's State of Union address two days earlier, the White House announced that the U.S. would be re-joining ITER with proposed huge new financial resources, which the U.S. Congress had specifically rejected a few years ago.

"I am pleased to announce that the United States will join ITER, an ambitious international research project to harness the promise of fusion energy," said President Bush. "The results of ITER will advance the effort to produce clean, safe, renewable, and commercially-available fusion energy by the middle of this century. Commercialization of fusion has the potential to dramatically improve America's energy security while significantly reducing air pollution and emissions of greenhouse gases." Energy Secretary Spencer Abraham will represent the U.S. at the upcoming ITER meeting in St. Petersburg, Russia. The ITER project already involved the UK, Russia, China, Japan, Canada, and other European nations.

It is likely that the U.S. Congress will go along with this odious, wasteful plan, which will accomplish no such thing as "commercially-available fusion energy by the middle of the century." *Infinite Energy* readers who are outraged by this new proposal to reward a monolithic program that has systematically attempted to kill virtually all attempts at alternative fusion research (including *other forms* of hot fusion!) might wish to contact their Congressmen and Senators to express their displeasure.

No acknowledgement of potential radically new sources of energy from hydrogen has ever been broached by this or the previous two U.S. administrations. Attempts have failed to have cold fusion/LENR (Low-Energy Nuclear Reactions) and/or hydrino physics dealt with properly in federal research, *i.e.* given a fair review by a Federal science panel,

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such as by the National Academy of Sciences. Thus, the tokamak (magnetic confinement hot fusion) juggernaut continues with renewed vigor. The "tokamak mafia" has, indeed, won big time. The academic coffers at MIT, Princeton, and elsewhere will be flush with new money.

Oblivious to the scientific revolution brewing around the findings of new, powerful phenomena—what we call New Hydrogen Physics Energy (cold fusion/LENR and hydrino science and technology), the ill-informed U.S. DOE moves onward like the stupid beast that it is, trampling down science, and gobbling up newly printed money. We cannot fault the President himself, who is no expert in the subtleties of science and science controversies. His self-interested, ignorant "science advisors" are simply misleading him.

President Bush in his State of the Union Address also revealed plans to assign $1.5 billion for R&D on the technology of automotive fuel cells. Two days later, the White House announced details of its fuel cell initiative: 1) More funding for research into fuel cell technology and 2) $720 million of the that funding specifically earmarked for technologies and infrastructure to "produce, store, and distribute hydrogen for use in fuel cell vehicles and electricity generation." This project will encompass partnerships with the private sector. The Administration claims that "Freedom Fuel" and "FreedomCAR" (Cooperative Automotive Research) initiatives will make it possible for Americans to choose clean hydrogen fuel cell vehicles by 2020—in large numbers. The further claim is that this will reduce the need for imported oil. Nothing could be further form the truth, since the use of *conventional* chemical hydrogen energy requires much more energy to produce hydrogen from water than is gotten back by the fuel cell conversion to electricity!

MIT President Charles Vest to Head DOE Task Force on Science

Speaking of science advisors who are misleading the President of the United States, we read with considerable interest—and dismay—this announcement in *MIT Tech Talk* (January 8, 2003):

U.S. Secretary of Energy Spencer Abraham has named MIT President Charles M. Vest to head the Task Force on the Future of Science Programs at the Department of Energy.

The high level task force will examine science and technology programs across the department and consider future priorities for scientific research.

"I'm grateful that Chuck Vest has agreed to chair this important task force," Abraham said. "I want to ensure that the Department of Energy remains on the frontier of research as we address our evolving missions in the future."

The task force will present its final report next summer to the Secretary of Energy Advisory Board, the highest external advisory board in the Department of Energy.

Vest also serves on the President's Committee of Advisors on Science and Technology (PCAST) and is vice chair of the Council on Competitiveness. He is the former chairman of the National Aeronautics and Space Administration Advisory Committee on the Redesign of the Space Station and former chairman of the Association of American Universities.

Among the other members of the 12-member task force is Robert Birgeneau, president of the University of Toronto and formerly MIT's dean of science.

So, the top man who will be leading the DOE's panel of the "future of science," Charles Vest, gets to pass judgment on whether hot fusion "science" should be funded at all, and if so to what extent, and at what institutions. One of those places just happens to be MIT, which receives tens of millions of dollars each year for its tokamak hot fusion research. Does this not seem to pose a slight conflict of interest? Will Vest recuse himself on the matter of hot fusion funding? Will there be any consideration of New Hydrogen Physics Energy by a panel led by Vest? Not a chance—not unless an irrefutable technological device gets powered by such energy and becomes too embarrassing for even Vest *et al.* to ignore. We recall that in 1991-1992 Charles Vest thought so little of what was going on in cold fusion/LENR, that he found it expedient to sweep under the rug allegations of improper scientific conduct by MIT hot fusioneers in their falsely reported experiments against cold fusion, researchers who had previously labeled the work of Fleischmann and Pons "scientific shlock" and "possible fraud." (See the 55-page report, "MIT and Cold Fusion" in *Infinite Energy*, Issue #24, soon to be posted as a public service for free downloading on our website, www.infinite-energy.com). Many years later, this science advisor to the President was heard by one *Infinite Energy* subscriber in private conversation to characterize cold fusion as a "flash in the pan." So with Vest in the top position, how is it possible for cold fusion/LENR to receive *any* re-assessment—let alone a *fair* one—for a role in DOE's future science programs? At best, the prospects are very poor.

As ominous as Vest's role on the DOE panel is the addition of former MIT dean of science Robert Birgeneau. When Birgeneau was head of MIT's Physics Department he remarked with pride in the department newsletter in the summer of 1989, "I should like to note, however, that none of our faculty contributed to the confusion surrounding 'cold fusion.'" In the spring of 1991 Birgeneau was unrepentant. He angrily contacted the MIT News Office to ask, "How did these flakes get on campus?" He was referring to two physicists, Drs. Fred Mayer and John Reitz, who had been invited to MIT by Profs. Peter Hagelstein and the late Lawrence Lidsky to give a talk on their theory of cold fusion.

With this kind of incompetent, biased scientific advising at the highest levels, expect no integrity in the assessment of truly frontier science programs proposed for DOE. Expect lots of new Federal money for research that threatens no physics paradigms or existing DOE programs.

Philanthropist George Mitchell Endows U.S. National Academies' Efforts in "Sustainability Science"

George Mitchell, a young engineer and petroleum geologist in Texas after World War II, pioneered the use of natural gas, which was then in the oil industry routinely burned off

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as a waste product. His Mitchell Energy & Development Corp. became a very successful energy business. He later sponsored the 1970s "Club of Rome" study, *The Limits to Growth*. In considering the concept of "alternatives to growth" with study author Dennis Meadows, Mitchell came up with the notion of "sustainable societies." This rubric, of course, is entirely based on the unstated premise that there are no radical new resources, such as effectively infinite, clean energy, to be found.

Now we read in the "InFocus" publication of the U.S. National Academies (National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council <national-academies.org>), that the Houston-based George and Cynthia Mitchell Foundation has given a gift of $10 million to the National Academies for the newly created George and Cynthia Mitchell Endowment for Sustainability Science. Another $10 million in future matching funds will come. "InFocus" (summer/fall 2002) gushes: "A key step in developing the capacity of the National Academies to undertake important new efforts on sustainable growth, the endowment will fund research, studies, and other activities in the emerging field of sustainability science and technology."

Mitchell is quoted, "What does sustainable growth come down to? Well, if you can't make the world work with six billion people, what are you going to do with nine and a half billion? How do we finally get enough collective organization and efforts in the next ten to forty years to really see how we resolve these issues?" Mitchell is apparently relying on the National Academies—and other science academies worldwide—to help solve the problems he sees. The no doubt well-intentioned Mitchell, and others like him who collectively lavish billions of philanthropic dollars on patchwork solutions using the conventional scientific paradigms of the various "National Academies," would be advised to look at what is going on in new energy. Perhaps they would come to see the benefit of funding research that would lead to an end-run around the world's environmental problems. This would be very hard work for such philanthropists, who would first have to overcome the nearly impregnable screens of deception about frontier physics and energy science that have been erected by such National Academies. But if only one such philanthropist would step out of line. . .

Life on Mars Controversy Re-Ignites

We reprint this exceptional piece from Dr. Tom Van Flandern's *Meta Research Bulletin* (Vol. 11, No. 4, December 15, 2002):

Life on Mars Controversy

A team of international researchers that included Prof. Chandra Wickramasinghe claims to have found what could be the first proof of life beyond our planet—clumps of extraterrestrial bacteria in the Earth's upper atmosphere.[1] Although the bugs from space are similar to bacteria on Earth, the scientists said the living cells found in samples of air from the edge of the planet's atmosphere (41 km) are too far away to have come from Earth. The local tropopause extends only to 16 km, above which no air from lower down would normally be transported. Using a fluorescent dye, the scientists detected living cells in the sample and estimated by the way their distribution varied with height that they are falling from space, and that as much as a third of a ton of the biological material is raining down over the entire planet daily. The space bugs provide strong support for the panspermia theory—which suggests that life may have come from outer space in the form of germs or spores.

This finding nicely complements that of Gilbert Levin, who recently concluded with a high level of confidence that the Labeled Release experiment aboard the 1976 *Viking* spacecraft apparently detected *living* organisms on Mars.[2] These in turn are consistent with the original findings of all three life detection experiments aboard that spacecraft.[3] Levin can now refute the only anti-life argument, a supposed destruction of organic molecules by putative oxidizing materials on Mars. But direct experimental evidence from *Mariner 9*, *Viking*, *Pathfinder*, and *Kitt Peak Observatory* clearly demonstrates that Mars does not have a highly oxidative surface.[4] This removes the primary reason commonly cited against the *Viking* Labeled Release experiment having detected microorganisms in the Martian soil. An unambiguous additional test for life is proposed for the next Mars lander.

Did NASA discover evidence of life on Mars and then misplace it for almost 25 years? Joseph Miller, a USC neurobiologist, recently conducted a careful reexamination of a fragment of a recovered NASA record from 1976 showing a surprising pattern: gas released by the Martian soil and tracked by *Viking* followed the same kind of rhythms followed by all Earth-bound organisms from humans to fruit flies in a cycle akin to feeding and respiration by colonies of microbes.[5] In one of those tests, a robotic arm on the probes scooped up soil samples, which were dropped into a dish along with a shot of a radioactive carbohydrate solution. Scientists reasoned that any organisms in the Martian soil would consume the nutrients and release radioactive carbon as a gas, something the probe was equipped to measure. *Viking* found clear evidence that the Martian soil generated gas over the nine-week experiment, but scientists at the time concluded that was the product of reactive chemical "superoxides" in the soil, not evidence of life. Miller found the gas emissions from the soil sample fell into a cycle of precisely the length of the Martian day—a circadian-rhythm-like pattern driven by a slight variation in the temperature inside the mostly insulated lander. Even more suggestively, the amount of carbon gas released rose over the course of the experiment until the temperature reached 320°F, but then dropped sharply. This suggests the temperature had reached the point where the bugs were killed.

1. 2002, http://www.space.com/searchforlife/bacteria_space_010731.html
2. 2002, *Icarus*, Vol. 159, pp. 266-267.
3. 1981, *Icarus*, Vol. 45, pp. 494-516.
4. 2001, http://www.biospherics.com/Mars/spie2/Spie2001Oxides/Spie2001-oxides.htm
5. K. Krolicki (2001/07/27) "Did NASA Overlook Life on Mars?" Reuters, Los Angeles.

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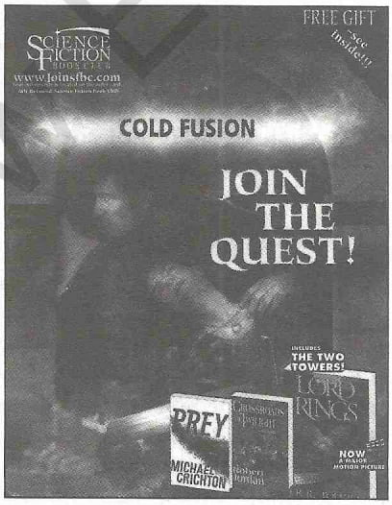
New Free Energy Device Claim Made

On January 29-30, 2003 Dr. Steve Greer of Space Energy Access Systems (SEAS) appeared on the Coast-to-Coast radio program (the "Art Bell Show," sans the now retired Art Bell) to make an announcement whose validity we cannot judge at this time. True enough, Greer and his colleagues seem very excited and certain about what they say they have observed of this new energy device, but mistakes have been made in the past, as Dr. Greer well knows. We await better information and would certainly like to see and test the claimed device ourselves. This is how the program was described on the Coast-to-Coast website:

> The first hour of the program offered a beacon of hope via Dr. Steven Greer's exciting announcement of the development of a new zero point energy apparatus. "It appears we have found a Holy Grail type device," Greer said. He's set up a company called Space Energy Access Systems to promote such innovations. "This is the most astounding. . .object I've ever seen in my life," he exclaimed, saying that the plan was to test and then make a prototype of it, before it was introduced to the public at large. The device which collects its own energy could fully power cars, homes and industries. Greer said that one reason he made this announcement on Coast was to prevent this amazing development from being suppressed or eliminated, as has often happened with energy advancements in the past.

Science Fiction Book Club Inadvertently Touts Cold Fusion!

We receive lots of junk mail asking us to join all sorts of book clubs. A recent piece of mail to Cold Fusion Technology, Inc., the former parent company of *Infinite Energy*, abbreviated our name as "Cold Fusion." The result was an ad that seems to be asking us to "Join the Quest!" for Cold Fusion! Hey, didn't they know we were on it already?! Here for your amusement is a greatly reduced image of the cover of the ad flyer:



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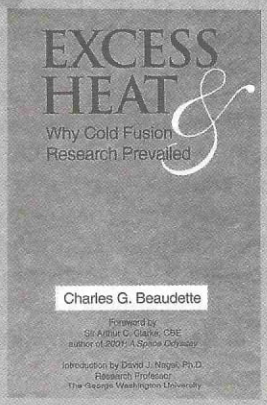

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Scientific Integrity and *Mainstream* Science

Theodore Rockwell*

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In legalese, the words that distinguish good science from bad are "mainstream" or "generally accepted." This is about as far as the law can go. This standard places a serious responsibility on the scientific community to ensure that *mainstream* science is indeed *good* science.

Institutions are scrambling to develop means to monitor and deal with departures from proper scientific practices. *Science* reported[1] that in Europe "a rising tide of retracted papers and some high-profile fraud cases are finally stirring research groups into action. . .the very structure of research institutions might be creating an environment that encourages research misconduct." The American Association for the Advancement of Science (AAAS) has published a quarterly Professional Ethics Report since 1988, with scores of reports in each issue on events relevant to scientific ethics. AAAS has also announced a Demonstration Project on Providing Independent Experts to the Federal Courts and cosponsored, with the U.S. Office of Research Integrity (ORI), a conference in Washington, D.C., April 10-11, 2000, on "The Role and Activities of Scientific Societies in Promoting Research Integrity." ORI decided to "downgrade the role of ORI in policing scientific misconduct" and issued a "government-wide research misconduct policy" statement[2] that defines misconduct, limiting it to fabrication, falsification, and plagiarism as described therein, and will "assist institutions unwilling or unable to do their own investigations [and] continue to review the results of university investigations and propose sanctions."

Scientists Will Be Held Accountable

Baylor College of Medicine found its molecular biologist Kimon Angelides guilty of fabricating data, stripped him of tenure, and evicted him from his lab.[3] He sued the university and fourteen of its officers and scientists, but he withdrew the action after the federal appeals board backed Baylor's findings that Angelides had "committed scientific misconduct." The appeals board concluded that the evidence showed "not honest error, not preliminary results that later proved overly optimistic, not even carelessness, but rather intentional and conscious fraud."

Lawrence Berkeley National Laboratory (LBNL) took similar action against its staff biochemist Robert P. Liburdy, finding that Liburdy "deliberately reported selected data, omitted contradictory data, and falsified results."[4] As a result, Liburdy was forced to retire, withdraw his findings, and be barred from all federal research for three years. Congress is pressing the laboratory to return at least some of the money that funded Liburdy's work, which may dampen the enthusiasm for any laboratory to find scientific misconduct in its midst.

Strikingly similar kinds of scientific misconduct seem to be happening in the radiation area. There are research reports widely cited as supporting current policy that, on closer scrutiny, can be seen to have conclusions that are contradicted by their own data. This is because the data have been improperly manipulated in the same way as the cases of scientific misconduct cited above, to bring about the desired but unwarranted conclusion. Such cases, if allowed to stand, tarnish the whole scientific enterprise. They can, and they will, be challenged.

An important fact to face here is that *there are cases where mainstream scientific opinion is bad science*—where scientific positions are maintained long after their invalidity becomes clear to any who will unblinkingly examine the refutory evidence. When reputations and incomes have been made and maintained by the "established wisdom" and the interests of funding agencies, there are strong personal and institutional incentives to hold off any changes as long as possible, pleading that we still do not know enough for sure, and a little more research money may make the situation clearer.

This situation can damage the integrity and credibility of the entire scientific enterprise if the mainstream opinion is later shown to be invalid and was under serious challenge by other credible scientists at the time in question. If opposing views are openly and honestly debated, there is no problem. The problem arises when the challengers are numerous and credible, and the challenges are not adequately considered and responded to by the mainstream science establishment.

Radiation Protection Standards

Current policy presumes that any dose of ionizing radiation, no matter how small, can lead to cancer and must be considered hazardous. This policy is contradicted by a large body of highly credible scientific evidence, but it provides support and professional benefits for the mainstream of the radiation protection field. But its continuance creates unwarranted public fear and hundreds of billions of dollars spent for no discernible public benefit. People are being

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scared away from life-saving medical treatments that involve radiation. People are dying from foodborne pathogens that could be killed by radiation. Scientists are forced to use less effective analytical techniques to avoid burdensome regulations associated with radioactivity. And fertile topsoil less radioactive than good farmland in Colorado or Norway is being dug up and hauled away for treatment because it is "radioactive."

> **An important fact to face here is that *there are cases where mainstream scientific opinion is bad science*—where scientific positions are maintained long after their invalidity becomes clear to any who will unblinkingly examine the refutory evidence.**

Credible challengers to the policy have become so numerous and so vocal for so long that mainstreamers now describe the situation as controversial. But this has not led to the needed examination of the refutory data and open debate as to its significance. Instead there have been three-year studies by mainstream committees such as the International Commission on Radiological Protection, the U.S. National Council on Radiation Protection and Measurements, and the committees on Biological Effects of Radiation. These committees are staffed by prominent scientists from prestigious institutions, but they self-select their membership and their successors, and they carefully exclude all of the many respected scientists whose work contradicts existing policy and provides replicable, statistically significant evidence that low-dose radiation is not harmful and is often beneficial. This evidence is not adequately dealt with in the reports that these committees produce, which create and support policy.

The normal procedures for challenging bad science are thwarted in this situation. Relevant research is reported in peer-reviewed journals and is formally presented to the committees and directly to the appropriate government regulatory agencies. But the evidence they present is ignored or summarily dismissed. The associated professional societies, such as the American Nuclear Society and the Health Physics Society, occasionally issue mild position statements and then back away from any follow-up action. Conferences of scientific and policy experts are called, but the meetings are not open and challengers are not invited. Sometimes a representative of an antinuclear organization such as Greenpeace is invited, but this is a political move, and their presence adds nothing to resolving the science issues.

Proposed radiation regulations are subject to public input. But we find that although other aspects of a proposed regulation may be discussed, the question of radiation health effects is considered defined by the review bodies and is specifically excluded from public challenge.

So the problem is routing out bad science when the bad science underlies a mainstream scientific position. Here hope lies in two facts. First, rules of good science are widely agreed upon, and the bad radiation policy persists, not because it is well defended as good science but only because it has never been forced out into the open. Second, although the policy is defended by the mainstream of the radiation protection community (which has much to gain personally and professionally from it), the wider scientific community is excluded. It is reasonable to expect that the mainstreamers would object, if given a chance. Although the funding of contradictory work is constrained, there are respected biologists, medical researchers, statisticians, epidemiologists, and other scientists outside the radiation protection community who have no conflict of interest in this matter, who could be expected to judge the issue fairly. They must be brought into the arena. If this problem is left for too long without a constructive response from the science community, the public reaction will be to question the integrity of all of science.

Several recent actions are accelerating this process. U.S. Senator Pete V. Domenici (R-New Mexico) has asked the General Accounting Office to investigate and report back by next June [2001]. Physicist-lawyer Richard Meserve, who played a leading constructive role in many of the recent actions to bring good science into policymaking, has been named chairman of the Nuclear Regulatory Commission. From the other side, Energy Secretary William Richardson announced that radiation is causing cancer and premature deaths to workers in nuclear plants, implying that scientists have known this for decades but have covered it up.[5] The Energy Department then stated,[6] "We estimate that over the next thirty years, there will be between 250 and 700 radiation-induced cancers, of which about 60% will result in death." This contradicts the position of virtually all responsible scientists in this area for over fifty years. The time has come for the scientific community to speak up on this issue. ❑❑❑

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About the Author

Theodore Rockwell, an engineer with over fifty years in nuclear power, is a founding officer of the engineering firm MPR Associates Inc. of Alexandria, Virginia, and a founding officer of Radiation, Science & Health, an international public interest group in Needham, Massachusetts.

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Reader Contributions and Critiques on

"Arc-Liberated Chemical Energy Exceeds Electrical Input Energy"

Peter Graneau, Neal Graneau, George Hathaway, and Richard Hull share with us scientific commentaries on their paper, "Arc-Liberated Chemical Energy Exceeds Electrical Input Energy," which was published in *Infinite Energy* #44 (it originally appeared in the *Journal of Plasma Physics*, Vol. 63, 2000). Also included is the authors' response to these commentaries. These dialogues are always welcome additions to *IE*.

Dr. Brian Ahern

I have trouble understanding the discrepancy in the value of E_{12}. Why is it over unity despite the presence of so many obvious energy loss mechanisms? I believe in momentum conservation. Therefore Equation 1 makes sense to me:

$$mu_{av} = (M + m)v_o \quad (1)$$

where u_{av} is the average velocity of the absorbed water and v_o is the initial velocity of the cork + fog. I also feel good about Equation 2:

$$\tfrac{1}{2}(M + m)v_o^2 = (M + m)gh \quad (2)$$

I used to do experiments like this with my high school science class when I taught at Wellesley High School.

Equation 3 is a time honored equation relating the height an object will rise to with an initial vertical velocity v_o.

$$v_o = (2gh)^{1/2} \quad (3)$$

In Equation 4 where you combine (1) and (3) to get

$$u_{av} = [(M + m)/m](2gh)^{1/2} \quad (4)$$

K.E. of the cork + fog = (M + m)gh = (0.065kg + 0.0005kg)(9.8m/s^2)(0.55m) = 0.35 J!

$v_o = (2gh)^{1/2} = (2 \times 9.8\text{m/s}^2 \times 0.55\text{m})^{1/2} = (10.8)^{1/2} = 3.3\text{m/s}.$

$u_{av} = [(.065 + .0005)/.0005](3.3) = 432\text{m/s}.$

$E_{12} = \tfrac{1}{2}\, m\, u_{av}^2 = \tfrac{1}{2}\,(.0005)(432)^2 = 46.7$ J of kinetic energy.

This value is higher than the energy stored in the capacitor (40 J) and one can expect to lose at least 50% of that stored energy during each high voltage discharge.

The kinetic energy of the water/fog could have been improperly accounted if some of the water is reflected back into the breech. If the amount of water initially moving upward was twice as large as the 0.5 gram figure that stayed attached to the cork, then only half as much kinetic energy would be required and the result for E_{12} would only be 23.35 J and E_{12}/E_2 < unity in all such cases.

Unfortunately, the relationship between energy and momentum shows that light masses are not very efficient at transferring kinetic energy as the cork only received 0.35/46.7 = 0.75%. The transfer is inversely proportional to the mass.

This mass/energy transfer condition explains why hydrogen is such a good absorber of neutrons. Each collision takes away half the energy as the proton mass in hydrogen molecules is roughly equal to the neutron. When neutrons scatter off metal nuclei, they lose less energy in each collision. This low energy loss allows for neutron diffraction spectroscopy.

Professor John O'M. Bockris

First of all I calculated the energy to evaporate 0.75 grams and it is impossible to evaporate this amount of water to steam with the energy you say was put into the system. It would take about 1,656 joules. Thus, *evaporation* of the water to form the fog is not feasible. Then, I calculated the energy to break the hydrogen bonds between all the water molecules and that turned out to need 2.04 kJ for the 0.75 grams so that is impossible, too.

I accepted your estimate of about 10^{-3} cm for the size of the drops and then I calculated the amount of surface tension work which would have to be done to break the hydrogen bonds and form drops of the size mentioned. I got a total amount of energy of 0.03 joules for that, so this can easily be done.

So, where I got to in these calculations was to find that there is plenty of energy left from the 57 joules to create drops of water of the size that you mentioned—and throw some of them upwards.

The fact that there is plenty of energy to do this does not, of course, explain an explosion and here I would like to go into a little digression of some work which I have done myself which may be indirectly relevant.

In 1987 I examined the dielectric breakdown in water. We applied fields of up to 3000 V per cm and noted that the platinum electrodes which we used developed a plasma-like looking glow, blue white, before the breakdown of the water

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(as a dielectric) occurred.

There is plenty of work on this dielectric breakdown of water and I was interested to notice the photos which you have put in the paper which you sent me, because they are markedly similar to photographs which have been taken of the initial process in the formation of dielectric breakdown.

What happens here is that the potential of the cathode exceeds the potential of the conductivity band of water and then electrons can be freely emitted from the electrode into the water. It is a fact in dielectric breakdown that there are "streamers" which are bunches of electrons which streak across the solution at one-tenth the velocity of light.

Therefore, we shall keep in mind that dielectric breakdown caused by the arc you form may be something on the way to your phenomenon.

Then, in 1994, I did some work in which I lit an arc between two spectroscopically pure carbon electrodes in highly purified water and found that if I kept all oxygen out of the water I could transmute a small amount of the carbon to iron, which gathered on the bottom of the vessel. Other people have replicated this work and found not only iron but nickel and cobalt as well in smaller proportions.

This is a true transmutation reaction and, of course, is anomalous within the present physics, but it is a replicated fact that it happens.

When I was doing the work with the carbon electrodes, I did some reading on the nature of arcs, etc., and I came across the fact that at the heart of the arc where the flame emits from the electrode the temperature is about 4,000°K.

With all this in mind, then, let us step back and see what we can see. How does a fog form in a general sort of way? With clean fog, one needs two conditions. Firstly, the vapor pressure of water should be abnormally high for the temperature and, secondly, there should be some solid particles floating around.

You won't find that everybody agrees with that opinion, but I am sure for the following reason. I did some work many years ago upon nucleation of vapors to liquids and the probability of nucleation in a totally clean system is very, very tiny. When a fog forms, it forms around some kind of solid nuclei which are present in the form of dust particles, etc.

So in order to explain your phenomenon, you have to have something which suddenly "kicks up" water droplets, but this water must be accompanied by a certain amount of solid "bits" on which the drops can adsorb and stabilize (gaseous colloid).

As my calculations show that it is easy with the 57 joules to create drops of water of about 10^{-3} cm, I propose that what happens is the suddenness of the pulse on the arc throws the water droplets up and they carry with them tiny particles from the electrode.

This model leaves open the calculation of the force necessary to *throw up the water droplets*. There will be electrostatic forces created by the arc and were I to know the details of it, I should be able to see if they are enough to throw up the drops. It is known that there is a magnetic force between a current carrying wire (*i.e.* the arc) and a dielectric, but I do not know an equation for this.

There is an error in your paper. Hydrogen bonds in water have an energy of ~6 kcal per bond. There are 4 bonds between two waters and so 12 kcal/mole of water.

Dr. Clarence Dulaney

You requested me to explain conservation of bond energies.

Atoms form bonds, releasing the "bond energy." At minimum, the same amount of energy is required to break the bond. This is simply *Conservation of Energy, which applies to chemical reactions* as well as physical transactions.

The only difference between reactions of atoms A and B, and ions A^+ and B^- is that the atom reaction requires a three-body interaction, with the third body to carry off the bonding energy. The ionic reaction takes place without the requirement for a third body.

If reactions took place according to your "potential energy" theory, there would fairly rapidly (over geologic time scale) be only atoms present, and no molecules. Every minute there are several lightning flashes occurring somewhere on Earth. These would cause atoms to be produced from molecules, according to your theory, and there would be no energetic incentive for molecules to form again, since to do so would require overcoming the "potential energy."

Hal Fox

The following comments are from experimental observations with high-density charge clusters (HDCC). HDCC are formed by short pulses of input electrical energy. Much of our work on HDCC has been accomplished in liquids. It is visually dramatic that when the HDCC are formed there are spark-like emanations from the electrodes. I noticed from your presentation at the conference organized by Tom Valone that your series of high-speed photographs began with a bright spot at the lower extremity of the arcing device. I would suggest that you may be creating a cluster of HDCC by the abrupt arc. The bright spot on the first frames shown in your presentation appear to me to visually demonstrate the formation of HDCC. According to the first charge cluster (EV) patent issued on HDCC—Kenneth R. Shoulders, "Energy Conversion Using High Charge Density," U.S. Patent 5,018,180, issued May 21, 1991—"An EV passing along a traveling wave device, for example, may be both absorbing and emitting electrons. In this way, the EV may be considered as being continually formed as it propagates. In any event, energy is provided to the traveling wave output conductor, and the ultimate source of this energy appears to be the zero-point radiation of the vacuum continuum."

One of the methods for producing HDCC is to have a high degree of local voltage gradient. For example, we often use zirconium electrodes because the zirconium oxide is highly resistive. In a liquid solution the end result is a strong voltage gradient across the zirconium oxide. In fact, almost all of the voltage drop in such a liquid occurs across the thin zirconium oxide layer. I certainly commend you on your pioneering work with explosive arcs. If indeed you are producing HDCC then there is an interesting possibility that the excess energy comes from tapping space energy.

Dr. Thomas E. Phipps, Jr.

The subject presents a problem in physical chemistry. Being a physicist of sorts, I am the last person to consult about it. . .hence the following remarks must be taken with a large grain of salt. The only "scientific" source of

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information I have at hand about water is the 14th edition of the *Encyclopedia Britannica* (1929), which says, "It seems probable that liquid water is a mixture of several types of molecules $(H_2O)_3$ and $(H_2O)_2$ predominating." In support of this it points out that "the latent heats of fusion and vaporization are much higher than those of other liquids, and this is attributed to the heat absorbed in breaking down complex into simpler molecules. The ice molecule—possibly $(H_2O)_3$—is undoubtedly bulky (witness the low density of ice), and the occurrence of a point of maximum density of water is probably due to the normal expansion of the liquid being outweighed by the contraction due to these $(H_2O)_3$ molecules, which have persisted in the liquid, breaking down to less bulky $(H_2O)_2$ molecules."

No doubt this pre-quantum-mechanical survey of the molecular situation in water would be judged quaintly primitive by present-day physical chemists. In particular, I am sure much more is known now about ice. Still there may be some validity in the picture of liquid water as a complex mixture of differently-aggregated molecular species dependent for composition on temperature and other parameters. The other parameters apparently include the water aggregate size, whether vapor, fog, rain, etc. According to such a picture it is not implausible that the literally shocking jolt of an electric arc passing through water in certain of its various states of aggregation might trigger a rapid alteration of those states and thus provide a source or sink of available energy. We can also, it seems to me, accept the empirical evidence of these authors that fog-creation from bulk water yields an explosive energy source.

This suggests further experiments that might be tried. If indeed the density maximum of liquid water at 4°C testifies to an extremum of molecular aggregation, it might be of interest to repeat the experiments with water at this temperature as well as at room temperature, and also with ice. The object would be to see if these changes of molecular aggregation in the water have any observable effect on the violence of the arc explosion (however measured). Starting with ice, would an arc occur and would fog be formed? If so, this might further validate the contention of these authors that the explosion product is *cold* fog. Also there are many kinds of ice, differing in their molecular aggregations and compositions. So there are plenty of research and thesis topics here, regardless of the practicalities governing a new energy source.

Finally, concerning the related topic of thunder, I was taught many years ago that it resulted from air rushing into the vacuum created by a lightning stroke. My father, a physical chemist, used to joke that everything in that subject was explained by either a "vapor" or a "vacuum." Maybe fog should be added to that list.

Authors' Response to Commentaries

The numerical figures used in *Ahern's* calculations are not directly taken from Table 1 of our paper, but nevertheless are representative of our results. His surprise that the apparent kinetic energy of the high speed fog, E_{12}, is greater than the energy that was initially stored in the capacitor bank, E_2, demonstrates the unexpected nature of the discovery of a new energy source. Such an energy gain has convinced us of the accessibility of internal water energy, E_8, which we believe is the potential repulsive energy stored in hydrogen bonds which is liberated when electrodynamic Ampère forces tear water apart into fog droplets.

Ahern expresses concern that we may not have correctly accounted for the mass of the water and fog which is responsible for the projectile acceleration. Our photographic evidence has revealed two mass flows from the accelerator muzzle. The first is the high speed fog jet (~200 m/s), followed by a flow of much slower and larger drops of water (1-20 m/s). The transition between these two states can be seen between frames 51-56 of Figure 4 of the original paper. A still photograph of the slow water drops, following the balsa wood projectile, which account for a significant proportion of the water discharged from the accelerator, is shown in Figure 1. As a result, it seems a reasonable assumption that all of the high speed fog ends up embedded in the soft balsa wood and is responsible for all the projectile acceleration. The bulk of the discharged liquid water has a low velocity and thus adds negligible momentum. Since water lacks the elastic properties of a solid it cannot be reflected back into the accelerator.

We are grateful to *Bockris* for his confirmation of our own calculations that the supply of energy is insufficient to boil the water, thus implying that we were unable to break the hydrogen bonds in the water by thermal collisions. He further agrees with us that there is a sufficient quantity of energy available to overcome the surface tension which opposes the tearing apart of water into fog droplets. Interestingly, he asserts that the figure we quote for the 2.2 kJ/g of latent heat is less than the estimated bond energy if each water mole-

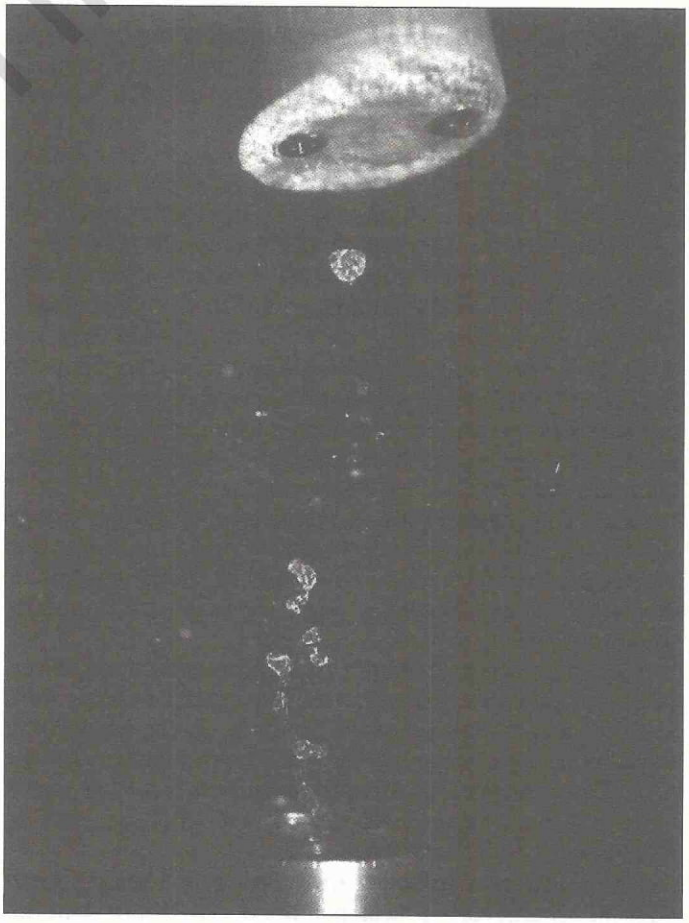

Figure 1. Photograph of slow water following the balsa wood projectile.

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cule is assumed to have four hydrogen bonds. However, the stored hydrogen bond energy density is not actually a constant, but hydrogen bonds have been measured to have at least two or possibly more energy levels. The total bond energy density therefore will be temperature dependent, since near the boiling point there will be more weak bonds than near the freezing point. Freezing is dominated by strong hydrogen bonds. Our figure of 2.2 kJ/g is a standard room temperature estimate of the latent heat and is equivalent to 9.9 kcal/mol. It corresponds to an average mixture of weak and strong hydrogen bonds.

The generated fog momentum is very dependent on the square of the arc current. For a given current strength, the fog momentum does not seem to vary with the arc voltage, which can be changed by adjusting the arc length. From this we conclude that the amount and strength of the fog explosion depends mostly on electrodynamic (Ampère) forces creating fog, rather than on the breakdown and ionization mechanism which is voltage dependent. Our arcs last only for micro-seconds and are surprisingly cool. The high temperature (4000°K) mentioned by Bockris probably applies to DC arcs which burn continuously.

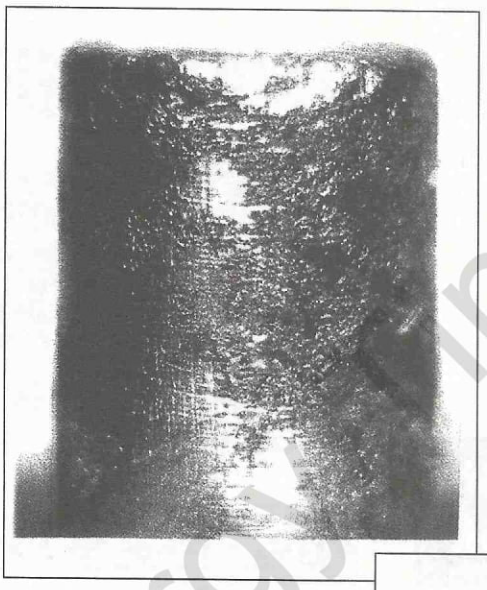

Figure 2. Metal deposit on anode.

Bockris' discussion of the normal method of fog production by nucleation-based condensation, as occurs in the clouds, seems, in our opinion, to be far too slow to produce the fog explosion in 10 μs, particularly since our fog is about 300,000 times as dense as that in a cloud.

With regard to nuclear reactions in the water arc, we should mention that we have performed water arc explosions in heavy water. The result was a 10% gain in the fast fog momentum. We ascribed this to the greater molecular weight of heavy water. Bockris' findings with regard to transmutation products is not inconsistent with our experimental findings, but we have no specific evidence to confirm or deny these results. We would be curious to find an estimate of the possible energy release from such a mechanism, based on the amounts of material which has been discovered in the experiments that he has discussed.

Dulaney's exposition of the current textbook view of "bond energy" highlights the shortcomings of thermochemical theory. This theory is based on the assumption that chemical bonds can only be broken or manipulated by thermal energy. However, as it appears that we are breaking bonds by electrodynamic forces, rather than thermal forces, it is likely that we are able to perform this task with much less energy than normally assumed. We view a stable bond as the algebraic sum of an electrostatic repulsive force and an equal attractive force which is caused by the relative orientation of the nucleus/electron dipolar charge distribution of the bonded pair of atoms (or molecules in the case of hydrogen bonds). It seems quite likely that the extreme current density of our arcs might disrupt the otherwise stable charge distribution that causes the attractive force, thus effectively eliminating it and allowing the electrostatic repulsive force to separate the bonded pair. Releasing this stored energy therefore adds kinetic energy (heat) to the local environment, which can then be the heat that is required to reform the bond in the normal manner at a later time. To continue Dulaney's example, this is the mechanism by which lightning can continuously dissociate molecules in the atmosphere and yet the atmosphere seems to repair itself in time with environmental and solar heat to produce bonding collisions.

In response to *Fox's* charge cluster discussion, we present the photograph of Figure 2. This shows the end of a $\frac{1}{4}$-inch stainless steel rod electrode in an accelerator like the one depicted in Figure 3 of the original paper, except that in this case the center electrode extends beyond the insulation breech into the coaxial water gap. The outer electrode was also made of stainless steel. With respect to the ringing discharge current, the center electrode was anode during the first current half-cycle, in which the maximum current flows. Figure 2 reveals a deposit on the anode which looks like having been produced by molten metal droplets which splashed sideways and then froze to the electrode. Presumably the liquid metal droplets were charged negatively and then accelerated across the inter-electrode gap. In this sense, they were negative charge clusters. It is now up to charge cluster theorists to explain how the negatively charged metal droplets flying through water can produce a cold fog explosion.

The bright spot which Fox saw on one of our high-speed photography sequences (see Figure 4 in the original paper) must have been the muzzle flash. We believe this is secondary light emitted by air molecules which are struck by intense electromagnetic radiation from the core of the arc. Most of the light emitted by a lightning stroke is of this nature.

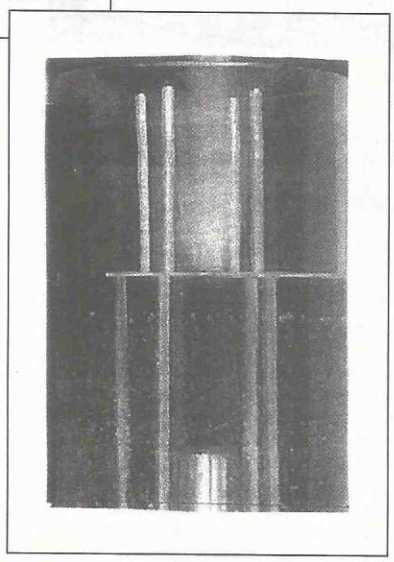

Figure 3. Fog jet above water surface.

Similarities between the molecular structure of ice crystals and clusters of water molecules in liquid water, as *Phipps* suspects, have been reported by several investigators. It is quite possible that the tiny fog droplets in our experiments, less than 1 μm in diameter, are structurally indistinguishable from ice and in this form fly through water at room temperature. Figure 3 is a video frame recently taken in the Hathaway Laboratory. The fog accelerator muzzle can be seen at the bottom of the

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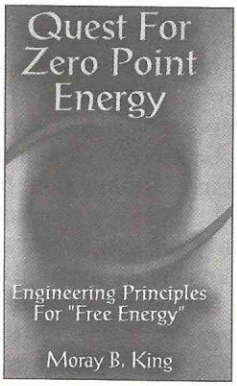
frame, submerged 10 cm below the water surface in a Lucite tank. The fog jet in air, apparently starting at the water surface directly above the fog accelerator muzzle, has a white appearance because of multiple light diffraction scattering at the many air/water interfaces. If the fog did fly through the water, diffraction scattering of light would be absent and the jet would be invisible. The average fog velocity in this experiment is expected to have been of the order of 200 m/s and one video frame allows ample time for the fog to fly from the arc in the accelerator to the top of the photograph. We leave it to the reader to decide what Figure 3 tells us, if anything, about the molecular structure of the fog droplets.

Phipps' suggestion of varying the water temperature before the fog explosions is very pertinent. Even though we did not concentrate on the temperature range between the freezing point and the point of maximum density (4°C), experiments in Oxford have shown a strong linear dependence between initial water temperature and fog momentum between $20 < T < 100$°C. This result seems to imply that the weaker the hydrogen bonds are at higher temperatures, the easier they are to break; thus, for a given amount of input energy, more bonds can be broken, leading to a larger quantity of liberated energy.

We would like to thank all five contributors to the discussion for taking the time to consider the paper and write to us. ❐❐❐



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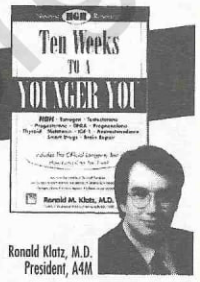

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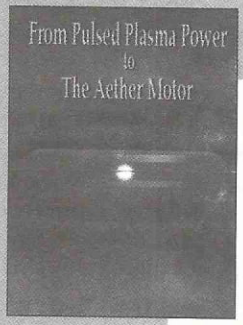

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Experimental Tests of the Normal and Retrograde Railgun Accelerators

Francisco J. Müller*

Abstract

Brass and steel rods were used to demonstrate the normal (forward moving) and abnormal (retrograde moving) railgun accelerators respectively. As horizontal rails, two bronze rods were used, each about 3 feet long. At one end of each rod a car battery was clamped to electrify the system, which became a closed circuit at the moment of laying the brass (or steel) rod across the two rails. Characteristically the brass rod advanced in the forward direction as expected (away from the battery bridge), whereas the steel (magnetizable) rod advanced backwardly.

When the same system is setup vertically, however, and the transversal rod is suspended on a balance (without rolling), no retrograde behavior is observed for the steel rod. Both brass and steel rods moved in the forward (expected) direction. The conclusion is that rolling of the steel rod is essential to observe its retrograde motion. Further experimental variations and a discussion is given in search for explanations of the observed effect.

The railgun accelerator is *"the testbed of Newtonian electrodynamics,"* according to the Graneaus.[1] Analysis of its action/reaction forces can be done using the Lorentzian-relativistic force, $F=qvxB$, or Ampere's original law. But only the latter seems to satisfy, piece by piece, Newton's Third Law. Much debate has occurred concerning this theoretical discrepancy. In a previous paper,[2] I have shown how the introduction of the electromagnetic momentum, as done by some defenders of vxB,[3] does not really solve the problem of Third Law violation.

To complicate matters, the Graneaus' also discovered the case where the moving element in the railgun is made of steel. Then it is projected not in the forward direction (escaping from the circuit) but backwardly.[4] This so-called "retrograde" or "abnormal" railgun has also been observed by Bardocz-Todor and Meszaros.[5]

In this paper (mostly experimental) I confirm the retrograde steel railgun behavior (Section 1, below). Then, by modifying the experiment (Sections 2, 3, and 4) I come to the conclusion that the retrograde behavior occurs only when the moving rod is free to roll. Further modifications try to throw some light on the retrograde case (Section 5).

1. Verification of the Retrograde Case

Two brass rods (1/4" OD) about 3 feet long were fixed to a wooden table by means of brass screws at one end (see Figure 1). Car jumper cables were attached to these ends and connected to a 12 volt car battery. The positive terminal was connected only after the moving rod, free to roll, was laid transversally upon the rails at, say, 1 or 2 feet from the clamped ends.

Non-ferromagnetic rods (brass, copper, or aluminum) rolled, as expected, away from the clamped end. The rods usually rolled only a length of 1/2" to 1" before the intense current melted the point of rolling and "froze" the motion. Sometimes a rod would not even move, due to this melting effect. A lighter (hollow) aluminum rod (about 1/2" OD) did travel all the way to the free end of the circuit and even fell to the floor. Hollow rods behave like the solid ones. Severe sparking was observed in all cases.

Once this normal behavior was fairly well tested, a steel rod was laid upon the rails. After energizing the circuit an unmistakable retrograde motion was observed, usually about 1" long, before melting occurred. This effect was so surprising that I have made several videotapes of it. My niece and nephew have presented it as science fair projects.

The question now arises: what would happen if we design a "double" railgun, *i.e.* having rolling rods at each end, intro-

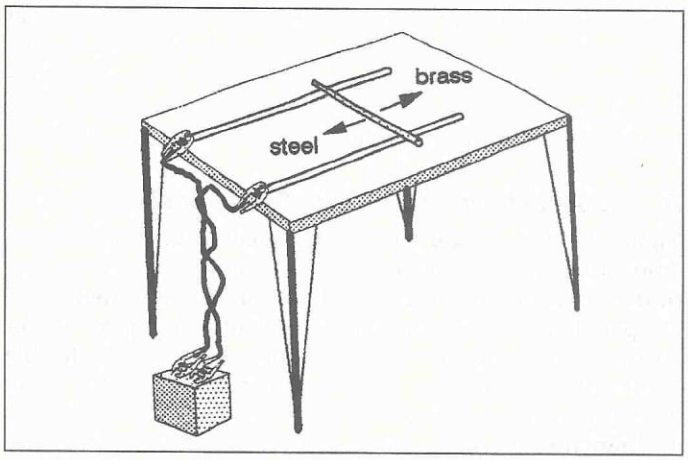

Figure 1. Normal and retrograde railgun accelerator.

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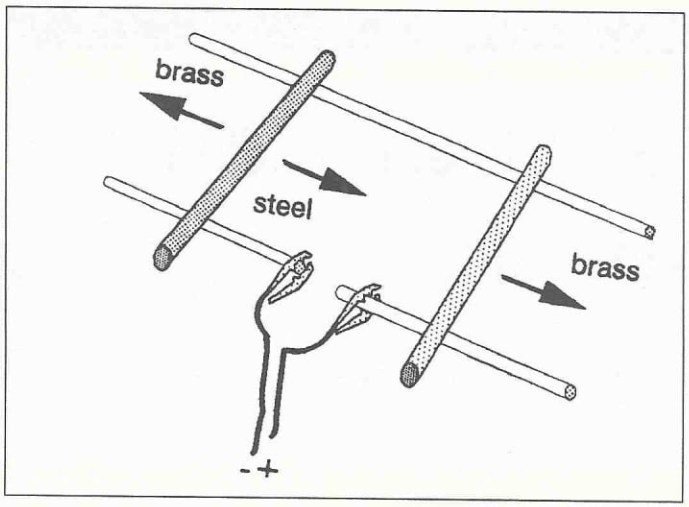

Figure 2. The "double" railgun accelerator. The voltage is introduced at the midpoint of one parallel rail. In this way (a) two transversal brass rods were observed to roll in opposite directions (both escaping form the circuit) as shown by the arrows; (b) but a steel rod placed at the left end moved to the right (!) in the same sense as the right brass rod.

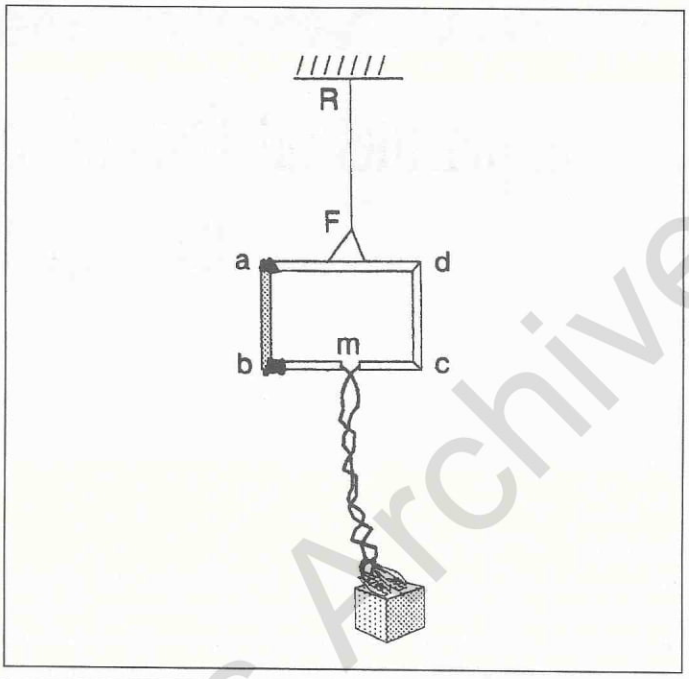

Figure 3. A suspended rigid "railgun." Side *ab* is a steel rod. The other three sides were made of copper.

ducing the voltage at the midpoint of one of the rails, and using a brass rod at one end and a steel one at the other?

2. The "Double" Railgun

Figure 2 depicts the situation described in the last paragraph. When the two rods were non-ferromagnetic, for example brass rods, a simultaneous motion of the rods was observed, each escaping from the circuit as expected for the normal case. They moved in opposite directions, complying with Newton's Third Law for the entire circuit.

Now, when one rod, say the right one, was a brass rod and the other a steel rod, the latter again did not escape from the circuit but moved to the right, *i.e.* closer to the circuit, where the battery connections are. The brass rod, as expected, did move escaping from the circuit, to the right. Thus, *both* rods moved to the right, giving the impression that Newton's Third Law is violated for the entire circuit if we use the Lorentz *vxB* field. Could the Ampere Law save the Third Law in this case?

Furthermore, could a self-propelled "spaceship" be constructed consisting of a rigid rectangular circuit, three sides made of brass and one of steel, so that upon electrification by a comoving battery, the system "self-propelled" in the direction of motion of the steel and brass transversal elements? To try this idea, a "suspended" rigid railgun was tested as follows.

3. The Suspended Steel/Brass Rigid "Railgun"

Figure 3 shows a rigid rectangular circuit *abcd* made of two horizontal sides of copper, one vertical side also of copper and another vertical side of steel. The latter was joined to the copper elements at *a* and *b* by means of thin copper loops. At the middle point *m* of *bc* the copper was cut and flexible cable connections were made to a car battery in the floor. The system was suspended from the ceiling by a long string RF branched at F so that the unequal weights of copper and steel were balanced horizontally. The cables to the battery were long and loose enough to allow the system to freely oscillate like a pendulum in its own plane *abcd*. This plane was initially oriented perpendicularly to the horizontal component of the geomagnetic field so that upon electrification of the system no net magnetic torque appeared on it.

If the behavior noted in Figure 2 when using a brass and a steel rod could be extrapolated to the present situation, then one would expect the vertical sides to play the role of the rods and the horizontal ones those of the rails. Hence, upon electrification, the system moves as a whole to the right since that is the direction in which both transversal sides moved in Figure 2.

When the system was electrified, however, *no* pendular motion was observed in any direction. To ensure that breathing in the room would not produce interferences, a video camera was installed in such a way that the vertical strings appeared aligned against some vertical feature in the room. After a long time of standing by in the closed room (so that air became pretty still), I enter slowly crawling on the floor to start the video recording and to connect the battery. Absolutely no motion of any kind was observed by the videotape as referenced by the vertical features of the room.

This was a first indication that the results obtained above with rolling rods could not be extrapolated to a static situation where the circuit elements cannot roll. To prove this point more convincingly, the next experiment was performed.

4. The Vertical Railgun Statically Pressing Against a Two-Pan Balance

Figure 4 is a perspective drawing of this experiment. The transversal rod *ab* is fixed to a piece of wood in turn affixed to a two-pan balance as shown. The vertical rails were two aluminum L bars about 4 feet long. The connections to the battery were made through two thick twisted wires leading to a switch box. From there the familiar jumper cables and car battery were used.

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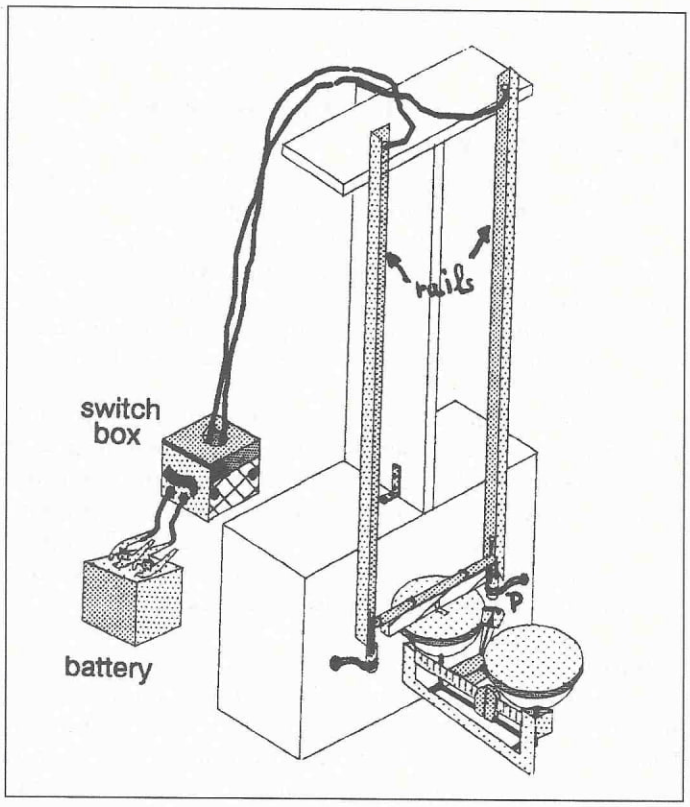

Figure 4. A vertical railgun whose moving element is sustained by an equilibrated two-pan balance.

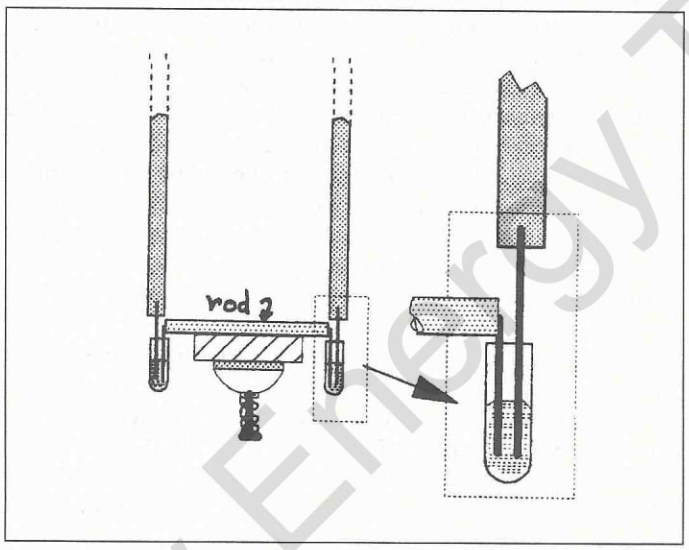

Figure 5. Details of the previous figure.

In order to establish connection of the rod with the rails and, yet, allowing for free vertical motion, copper pins were soldered to the ends of the rails and rod. These were, in turn, immersed in mercury cups as shown by the insert of Figure 5.

The pans were balanced with the scale counterweights and a video camera was set close to the pointer P. A downward motion of the pan was easily observed by the pointer's motion to the left. This would happen in the case the rod was expelled from the circuit, as expected for the normal case. In the retrograde case, the rod should tend to go up "into" the circuit, thus decreasing the pan's weight and moving the pointer to the right.

When a brass rod was put on the pan the force was downwards as expected. To ensure that the effect was not an inductive one (*i.e.* was not due to the moment of current build-up in the circuit), the balance was held by hand at the moment of electrification and then released a second after. The pointer again moved violently to the left, indicating that the force pushing downward was, indeed, a magnetostatic force, not an inductive one.

With this technique in hand the brass rod was replaced by the same steel rod used in the previous experiments. An upward (retrograde) force was expected. The pointer, however, moved to the left, evidencing a downward (normal) force. Again, the balance was held by hand during electrification and released one second after. The motion was still normal, in the downward (escaping) direction.

In this fashion I think I have proven that the retrograde motion observed with steel rods in the experiments of Figures 1 and 2 is essentially dependent upon the fact that the rod is *rotating*. Static steel rods, like those of Figures 3, 4, and 5, would behave just like non-ferromagnetic ones, being expelled from the circuit as normally expected.

The question is, then, why rotation of the steel rod so dramatically affects the direction of its electrodynamic motion in the railgun system. In search for a reason, more experimental variations were performed.

5. Further Experimental Tests

a) Following a suggestion by J. Paul Wesley, the steel rod of Figure 1 was prevented from contacting the rails by means of two aluminum jackets 1" long. The idea was to test if the retrograde effect could be due to some trivial "contact effect" at the rolling points. The steel rod, however, did not move in any direction after being surrounded with those jackets. Most probably the weight of the rod slightly deformed the aluminum, increasing rolling friction too much.

Pursuing the same idea, the steel rod was next inserted inside a wider, sturdy brass tube so that, again, the brass "jacket" prevented the steel from touching the brass rails. This time the system did move after electrification. And it did so still in the *retrograde* (!) direction as if no brass surrounded the steel rod. No quantification was done, but it was qualitatively clear that the motion occurred about a second after electrification, *as if* a "conflict" had to be resolved between the hollow brass tending to move forward and the steel moving backward. In fact, in one trial, the system moved backward about one full inch, stopped and then moved forward almost a half inch before melting occurred (see Figure 6).

b) To search for this point I tried the retrograde experiment with pre-magnetized steel rods, but could not get any strong magnetization to change the usual behavior.

c) To see if the degree of magnetic permeability altered the retrograde case, I tried the experiment with a regular iron nail about 3" long. Amazingly the nail *did not* move in the retrograde direction, but forwardly like the copper, brass, and aluminum rods. So it seems that the high permeability of steel is needed for backward rolling.

Finally a mechanical model was tested, following the suggestion of a physics professor at the University of Miami.[6]

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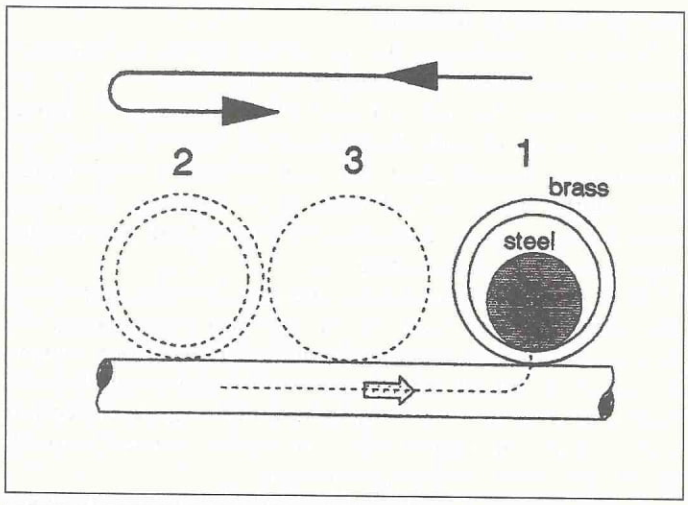

Figure 6. Sideview of a steel rod rolling inside a brass tube. After electrifying the rails in the direction of the white arrow, the system moved 1" backward from 1 to 2, but then stopped and moved forward about 1/2" to position 3.

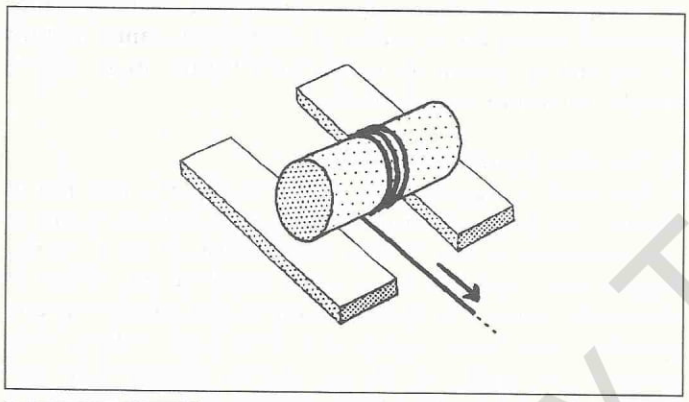

Figure 7. Proposed analogue of the retrograde railgun. If the rails are rough the spool will "catch on" the surface and because of the rotation impressed by the force pulling to the right it might roll backward, to the left.

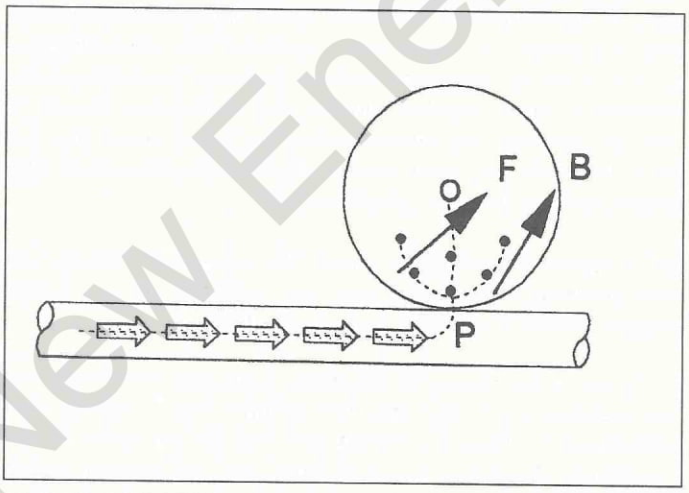

Figure 8. Side view of the rolling rod. The dots represent possible paths for the currents entering the rod from the rail. The white arrows represent current elements along the rail. Forces generally directed like *F* and *B* might produce forward or backward rolling, respectively.

This was supposed to be a mechanical analogue of the retrograde motion, although I think it is not (see Discussion).

6. A Proposed Mechanical Analogue of the Retrograde Railgun

This is the elementary problem of a string spool set horizontally on smooth (or rough) rails (Figure 7).

If the string is pulled out horizontally from the lower rim of the spool, the latter might: (a) *slide* as a whole in the direction of the pulling force if the rails are frictionless; or (b) rotate because of the applied torque, catch on the rough rails, and roll backward, in the direction opposite to the pulling force.

So the same force can produce motion in the forward or retrograde directions depending only on the circumstance of the rails being rough or smooth. Likewise, the professor suggests, the railgun can move forward or backward depending on the exact path of the current inside the rod. This path would place the electrodynamic pushing forces in such a way that the rod might roll forward or backward.

Discussion

The mechanical analogue just proposed has a serious defect: in the electrodynamic railgun there is rolling forward or backward, *i.e.* always rolling; but in the spool case there is rolling in the retrograde case but *sliding* in the forward one. It is difficult to see how the path of the currents across the rod must change so that the electrodynamic (supposedly) always pushing forces might make the rod rotate in one sense or the opposite. Observe the diagram of Figure 8, which is a side view of the rolling rod. The dots represent possible paths of the currents entering the rod from the rails. Any force *F* applied to the left of *OP* (where *P* is the instantaneous fixed point of rotation), will produce a torque making the rod roll in the clockwise (forward) direction. For backward rolling the forces ought to be applied at the right of *OP*, say like the force *B* in the diagram, and must have such an inclination that the leverage about *P* produces counter-clockwise rotation. It is difficult to see how such a force *B* can arise from current elements (see arrows) located at the left of *P* along the horizontal rail.

If the mechanical explanation is disqualified, then we are left only with an intrinsic change of direction of the electrodynamic forces to explain the retrograde steel motion. But then, why did the static case of Figure 3 fail to show the expected combined motions of steel and copper? Again, why did the suspended case of Figures 4 and 5 not show retrograde motion of the steel?

These are questions I leave for the theorists to answer, my purpose in this paper being only to describe the experiments. Ampere's theory can predict the null motion in the case of Figure 3 if reverted magnetic forces are added to the interaction between the steel rod and the other sides. But it cannot explain the normal (forward) motion observed in Figures 4 and 5. On the other hand, the Lorentz and Biot-Savart term, *vxB*, cannot explain those experiments if reverse forces are used.

Although I failed to test the case of rolling a permanently pre-magnetized rod, a valuable piece of information was obtained by Ligon,[7] who showed that in that case the rod might roll backward or forward depending on the direction of magnetization respect the electric current.

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Also it must be noted that in the case of the rolling experiments, the rods are not strictly coplanar with the rest of the circuit. As a result there is a sharp (90 degrees) bending of the current direction before passing from the rails to the rod or vice-versa. This must be considered in the analyses.

A final word about the copper pins used in the experiment of Figures 4 and 5. On purpose they were placed parallel to each other so that their interaction would be perpendicular to the passing vertical currents. In this way they will not interfere with the free vertical motion of the rod and balance.

Conclusions

Rotation has been found to be a required condition for a steel rod to show retrograde rolling in the railgun accelerator. No explanation was proposed to explain this requirement, although a simple mechanical analogy with a rolling/sliding spool was found inappropriate. Something more fundamental is involved here and it seems that Amperian electrodynamics will be, in the long run, more capable of solving the problem than the established Lorentz-Biot-Savart *vxB* effect.

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About the Author

Francisco J. Müller (born in Cuba, 1939) came to the U.S. in 1962 after Castro closed Villanova Catholic University, where he was studying chemical engineering. In the U.S. he finished a BS (1962) and MS (1994), both in physics. Between those two dates he worked as associate researcher for the Internal Medicine Department of Miami University (27 years) and also developed an independent research in electromagnetic induction (30 years), specializing in "unipolar induction." An accomplished pianist, Müller played with the Miami Philharmonic for many years, and also at Carnegie Hall in 1999 with the Miami Symphony. Presently he teaches college physics and astronomy and continues to write articles and lecture in various topics of philosophy of science, natural philosophy, and physics (unipolar inductor, the Sagnac effect, the railgun, etc). Müller is currently president of the Natural Philosophy Alliance and of the Varela Academy of Science and Philosophy.

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Salaam to the Infinite Energizer

Graham McGill*

On March 23, 1989, the day before the Exxon Valdez spilled millions of gallons of black, sticky crude into the pristine waters of Prince William Sound, I was working as Front Page Editor at the *Schenectady* (N.Y.) *Gazette*, when Drs. Martin Fleischmann and Stanley Pons, Utah chemists, announced that they had produced excess heat in a jar of heavy water with a palladium electrode—heat they attributed to some new kind of radiationless nuclear fusion, subsequently dubbed "cold fusion." This could lead to vehicles that ran on water, an economy independent of oil, and household devices that produced electricity, in short, to a new age and lifestyle, so I led the paper with it. Trouble was, the story petered out. After a few followups the wires went silent, and within a few weeks, this potentially gigantic good news simply vanished, and I never found out what happened, nor the reason for the sudden hush. Which left me and many readers up in the air. But other matters eventually proved distracting, and the mystery slipped into dimmer recesses at the back of my mind. Until years later.

Retired then, I was watching "The Mysterious Origins of Man" on TV, with Richard Milton, English author, ripping into Darwin—our bastion of biological thought since the mid-1800s—insisting that the Theory of Evolution wasn't as cut and dried as we'd been led to believe, that many anomalies indicated that mankind was much older than commonly accepted, even perhaps, that we had not descended from ape-like creatures, which I'd thought had been more or less taken for granted since the Scopes Trial in 1925.

I was immediately enthralled—first, because Milton was clear and direct; and second, because of his chutzpa. So I ordered his *Shattering the Myths of Darwinism*, found it wasn't available locally, but turned up *Alternative Science: Challenging the Myths of the Scientific Establishment*, which told me what happened to cold fusion.

At the time of its printing in 1996, seven years after the Exxon Valdez, cold fusion had been corroborated by hundreds of reputable labs all over the world, but few were talking about it. Why? Because of what Milton called "the taboo reaction."

When first announced, cold fusion required great care and nearly pure palladium to replicate, so several major labs quickly pronounced it a fraud or a mistake, including MIT, Cal Tech, and Harwell in England. This resulted in Pons and Fleischmann being discredited, vilified, and finally forced to leave the country, after which only a few holdouts were brazen enough to risk supporting them.

This kind of rebuff, according to Milton, had been the initial fate of hundreds of successful inventions, including the airplane by the Wrights, the light bulb by Edison, the marine turbine by Parsons, and television by Baird, to mention a few. But as of the time of this writing (February 2003), despite much evidence to the contrary, cold fusion still hasn't been publicly accepted. It has become taboo.

Paradigms resist change, it seems, so that, when faced with new data, members of a group tend: 1) to rely on the judgment of those they think are in a better position to know than they are, 2) to ignore the new data, 3) to mock the new data, and 4) to excoriate the sources of the new data. All this happened with cold fusion.

Peer review apparently contains a large element of mostly unconscious peer pressure, to which scientists are just as susceptible as the rest of us, but they aren't likely to believe this. They think they've been trained out of it. Dr. Carl G. Jung, eminent Swiss psychologist, explains it thus:

> The element of differentiation is the individual. All the highest achievements of virtue, as well as the blackest villainies, are individual. The larger a community is, and the more the sum total of collective factors peculiar to every large community rests on conservative prejudices detrimental to individuality, the more will the individual be morally and spiritually crushed, and as a result, the one source of moral and spiritual progress for society is choked up.
>
> *Two Essays on Analytical Psychology, Collected Works,* Vol. 7, p. 150

About this time my wife Sherrill did a story on Paul LaViolette, a local scientist and author of *The U.S. Antigravity Squadron*, which described T. Townsend Brown's link between high DC voltage and gravity, and theorized its use in the B-2 bomber—"electrogravitics," as it's now called, being just as beyond the public pale today as cold fusion. But I saw in it a possible connection between an airplane, and a blinking, eye-popping dream I had in 1968.

But what could a dream have to do with our need to speak the truth? Quoting Dr. Jung again:

> The dream is a little hidden door to the innermost and most secret recesses of the soul, opening into that cosmic night which was psyche long before there was any ego-consciousness, and which will remain psyche no matter how far our ego-consciousness extends. For all ego-consciousness is isolated; because it separates and discriminates, it knows only particulars, and it sees only those that can be related to the ego. Its essence is limitation, even though it reaches to the farthest nebulae among the stars. All consciousness separates, but in dreams we put on the likeness of that more universal, truer, more eternal man dwelling in the dark-

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ness of primordial night. There he is still whole, and the whole is in him, indistinguishable from nature, and bare of all egohood.

The Meaning of Psychology for Modern Man, Collected Works, Vol. 10, p. 144

This was my dream:

An old friend and I are trekking across rough terrain at night. We stop to rest on a ridge. In the distance I see a spacecraft, rising without noise, flame, or smoke, propelled upward by flashes of light striking its tail. I turn to share my awe with my friend, but he's not there. He's down in a gully between me and the spacecraft, where he can't see it, and being harassed by a collie dog. Knowing I can help, I stand up and holler, "I'll be right there!" And the image dissolves.

Though I have tried repeatedly to interest my friend in cold fusion and electrogravitics, or at least make them seem reasonable to him, it was like talking to a stone, which didn't really astonish me because, when I'd tried to share my awe with him in my dream, he wasn't there. So I kept reminding myself that one man's evidence is another's trifle, and that we are not all of one mind, and that discernment is an individual differentiation. "Those who have eyes to see" is the Bible's phrase for it.

Also, my friend's alma mater is that "bastion of skepticism," MIT. This is sad, because he is in a position to help cold fusion, but probably won't.

But Dr. Jung wrote:

"Society" is nothing more than the concept of the symbiosis of a group of human beings. A concept is not a carrier of life. The sole and natural carrier of life is the individual, and this holds true throughout nature.

The Practice of Psychotherapy, Collected Works, Vol. 16, Bollingen Series XX, p. 152

Further:

When we consider the history of humanity, we see only the very outer surface of events, and even these are warped by the dim mirror of tradition. What really happened escapes historical research, for the real historic happening is deeply hidden, lived by all and perceived by none. It is the most private, the most subjective, psychic life and experience. Wars, dynasties, social revolutions, conquests and religions are all the most superficial symptoms of a secret psychic fundamental attitude in the individual, unknown to him and therefore not recorded by any chronicler. The great events of world history are in themselves of small importance. What is important in the final reckoning is only the subjective life of the individual.

Psychological Reflections, Jolande Jacobi, ed., p. 139

And:

When I counsel my patient to pay attention to his dreams, I mean: "Turn back to the most subjective part of yourself, to the source of your being, to that point where you are making world history without being aware of it. Your apparently insoluble difficulty must, it is obvious, remain insoluble, for otherwise you would wear yourself out seeking for remedies of whose ineptitude you are already convinced. Your dreams are an expression of your inner life, and they can show you through what false attitude you have landed yourself in this blind alley.

Civilization in Transition, Collected Works, Vol. 10, p. 149

Most Jungians, I thought, restricting themselves to what they'd agree was "scientific," would probably limit my silent light-driven spacecraft to mean what Jung called "the transcendent function," as pictured in *Man and His Symbols* (p. 157). But if I considered the broader view as set forth in the Edgar Cayce readings, I might suspect a prehistoric origin.

Is this scientific? Perhaps not, in a collective sense. But I believe it's at least reasonable, and I'll try to explain.

The Cayce story, or aspects of it, has been told in over 500 books. Many are still in print. Calling himself a "psychic diagnostician," Edgar could put himself in a trance, zero in on patients at a distance, pinpoint illnesses, and prescribe treatments. He died in 1945, but left over 14,000 readings, still accessible, thanks to his secretary, family, many friends, and the A.R.E. (edgarcayce.org). In 1923 he began giving what were called "life readings."

In her book *Many Mansions* (p. 288), published after his death, Dr. Gina Cerminara tells why these readings should interest us:

Character analysis and descriptions of circumstances were correct, on total strangers, at distances of hundreds of miles and in thousands of instances.

Predictions of vocational abilities and other traits proved accurate in later years, not only for adults, but also for newborns.

Psychological traits were plausibly accounted for by presumable past-life experiences.

The data was self-consistent over a period of twenty-two years; that is to say, it agreed with itself, both in principle and in minute detail, in hundreds of separate readings taken at different times.

Obscure historical details have been verified by consulting recorded history; the names of obscure former personalities have been found in the locality where the reading said they could be found.

The readings had a helpful, transforming influence on the lives of persons who received and followed them.

The philosophical and psychological system which is implicit in and deducible from the readings is coherent, consistent, and sufficient to all known facts about mental life, and conducive to the discovery of new explanations for unexplained aspects of mental life. It agrees, moreover, with the ancient and honorable philosophical doctrine that's been taught in India for centuries.

Also, according to noted scholar Rabbi Herbert Weiner, the concept is included in the ancient Jewish mystical document, the Kabala.

The "philosophical and psychological system" Dr.

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Cerminara refers to goes like this: God created man "in His own image," that is, as a soul with free will, with the ability to love, or not to love, so that men might willingly become His companions in the spirit. About ten and a half million years ago, experimenting with this free will, a group of us "pushed ourselves into matter," that is, took on material bodies, and became so infatuated with earth life that we lost consciousness of the Original Source of Life. We were trapped in the earth on what Buddha termed "the wheel of return," by "the snares of the ten thousand things." So God sent in a rescue squad—the Israelites—whom Cayce called the Sons and Daughters of the Law of One. Their story is told in the Old Testament.

This path, or Tao, or Way, is touched on by Tom Sugrue, author of a Cayce biography, *There Is a River*, in Reading 5749-14:

> (Q) From a study of the (life readings) it seems that there is a trend downward, from early incarnations, toward greater earthliness and less mentality. Then there is a swing upward, accompanied by suffering, patience, and understanding. Is this the normal pattern, which results in virtue and oneness with God obtained by free will and mind?
>
> (A) This is correct.

Why, then, is the concept of reincarnation not in the Bible? Well, it was, Cayce said, but was more or less expunged by those who wanted to keep the people under their thumb, that is, restrict their access to the truth. In other words, censored. Sound familiar? But traces of it can still be discerned by "those who have eyes to see."

For instance, John 9:2: "And his disciples asked him, saying, Master, who did sin, this man, or his parents, that he was born blind?" The question of "this man" sinning though born blind shows the disciples assumed he'd lived before, Cayce said.

Further, in John 3:1-3:

> There was a man of the Pharisees, named Nicodemus, a ruler of the Jews: The same came to Jesus by night, and said unto him, Rabbi, we know that thou art a teacher come from God: for no man can do these miracles that thou doest, except God be with him. Jesus answered and said unto him, Verily, verily, I say unto thee, Except a man be born again, he cannot see the kingdom of God.

Jesus was referring to reincarnation, Cayce said, Jesus being the same soul who had led the Sons and Daughters of the Law of One into the earth as Adam, then Enoch, Hermes, Melchizedek, Joseph, Joshua, Asaph, Jeshua, Zend, and finally Jesus, thereby becoming the Alpha and Omega, and showing us the way back to fuller awareness of our Source.

And these two examples don't exhaust the Bible's past-life allusions, if "you have eyes to see."

So this rescue squad began incarnating in the Garden of Eden, located on Atlantis, and after a time developed many technological marvels—"the reading of inscriptions through walls, even at a distance" (X-ray or infrared photography) (519-1); "fluxes of metals unknown today" (metallurgy) (364-13); "transmission of the voice" and "television" (813-1); "rays of various kinds. . .including the death ray" (laser and neutron beams) (364-13); "transmission of the body" (teleportation) (813-1); "the overcoming of forces. . .even of gravity itself" (519-1); "air and water craft. . .propelled by forces from the sun's rays—caught and reflected by crystals" (364-13).

In fact, Cayce said, many Atlanteans, incarnated again today, are developing "modern" technology.

But over the millennia, Cayce said, "The use of these influences by the Sons of Belial (those who'd lost consciousness of the Source of Life) brought, then, the first of. . .what we would call a volcanic upheaval" (877-26). This eventually led to Atlantis' destruction.

This story is partially corroborated by the Greek philosophers, Solon, Socrates and Plato, six to four centuries B.C., and recorded by Plato in one of his *Dialogues*:

> For many generations, as long as the divine nature lasted in them, the people (of Atlantis) were obedient to the laws, practicing gentleness and wisdom in their intercourse with one another. They despised everything but virtue, thinking lightly of gold and other property, which appeared only a burden to them. Neither were they intoxicated by luxury, nor did riches deprive them of self-control. They saw clearly that worldly goods are increased through friendship with one another, and that by excessive zeal for them the good is lost and friendship perishes. By such reflections of a divine nature, all that we have described increased in them. But then this divine portion began to fade away, and they, unable to bear their good fortune, became unseemly, and began to appear base. Yet to those who had no eye for true happiness, they still seemed blessed at the time they were bursting with unrighteous avarice and power.

Of course, this awareness of the Law of One doesn't occur to all the so-called rescuers at once. It occurs to each one at a time, and requires him or her to tread the path, acquire the virtues, bear his own rebuffs, deal with his own defects, and experience his own vicissitudes.

Scientific? Well, I prefer the word "reasonable."

Discernment, judgment, wisdom are what make us all different—"differentiation," Jung called it. And if true, this story explains why we must keep speaking the truth. It's a battle we may have joined, an assignment we may have accepted, a vocation, a calling—I'd like to use the word "mission"—we may have embraced, in the spirit of a very long haul. ❐❐❐

About the Author

Graham L. McGill is author of *Arctic Rendezvous*, a spiritual adventure set in Alaska; and the compiler of *No Death: God's Other Door*, Hugh Lynn Cayce's anecdotes about his and his father's journeys into realms of the soul. He worked as an editor at the *Schenectady* (N.Y.) *Gazette* from 1964 to 1991, and was a U.S. Air Force pilot from 1953 to 1957. He likes to swim, hike, backpack, do handyman work for friends, and is currently writing another book, from which "Salaam" was developed.

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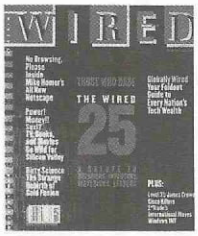

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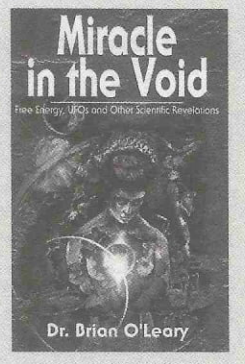

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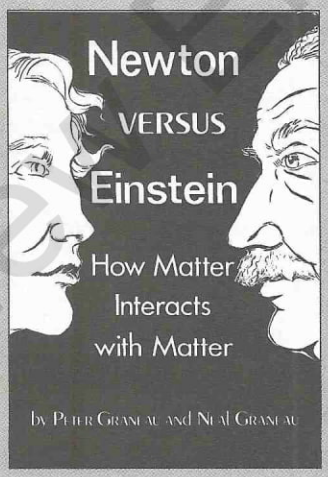

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Send paper abstracts by March 1, 2003 to:
Dr. Cynthia Whitney, dwhitney@mit.edu

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Conference Goals

Consistent with previous International Conferences on Cold Fusion, the goal of ICCF10 is to further scientific knowledge of effects—identified initially during 1989—with phenomena associated with anomalous, low-energy nuclear reactions in condensed matter. The conference is intended to be an open forum for scientific discussions related to the advancement of knowledge associated with this topic, including:

- Temperature increases, power and energy production in metal hydrides and deuterides; calorimetry relevant to such experiments.
- Correlations, or lack of correlations, between energy production and possible nuclear products.
- Materials science issues that are important for the development of nuclear effects in condensed matter.
- Electrochemical issues concerning loading, surface chemistry, resistance diagnostics and other issues concerning metal hydrides and metal deuterides that relate to anomalies.
- Observations of low-level dd-fusion reaction products in metal deuterides.
- Charged-particle, X-ray and gamma emission from metal hydrides and deuterides.
- Tritium production in metal hydride and metal deuterides.
- Production of new elements or isotopes in metal hydrides and metal deuterides; and modification of the associated isotopic distributions.
- Induced radioactivity in metal deuterides and metal hydrides.
- Accelerator experiments on metal deuterides and metal hydrides that pertain to screening and the anomalies.
- Screening between nuclei in the condensed matter environment.
- Models for relevant nuclear processes in the condensed matter environment.

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Focused morning and early afternoon plenary sessions, as well as poster presentations in the later afternoon. There will be space for a limited number of exhibits, experiments, or working cold fusion devices. These will be presented in a laboratory at MIT, located within walking distance of the hotel. If you are interested in exhibiting, contact M.C.H. McKubre (michael.mckubre@sri.com).

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One-page abstract submission	July 1, 2003
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Notification of acceptance	July 30, 2003
Full paper submission	Sept. 10, 2003

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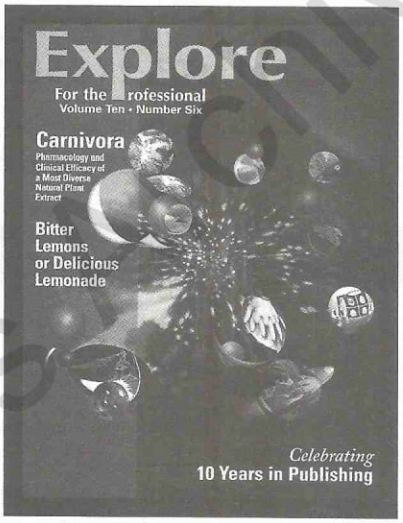

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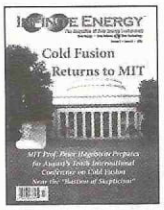

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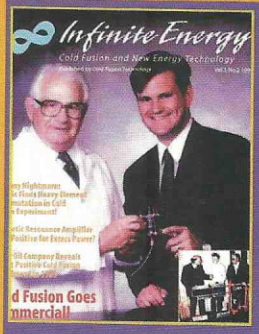

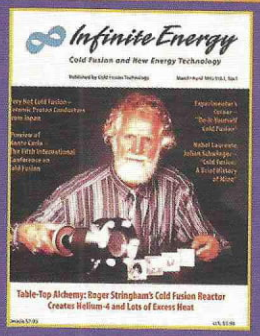

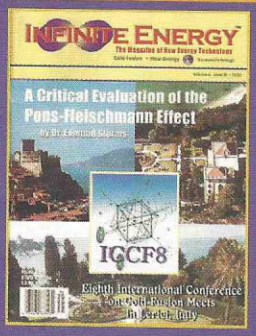

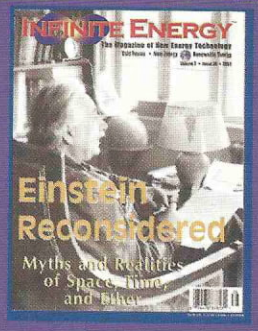

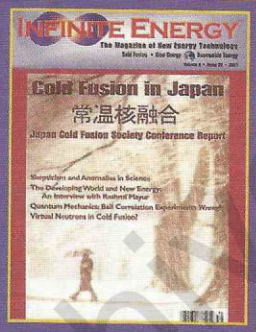

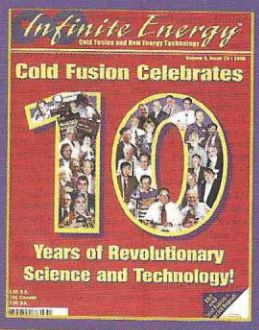

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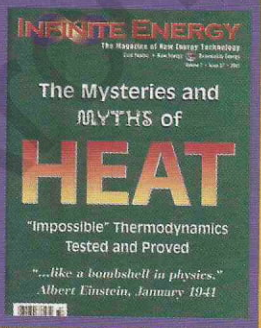

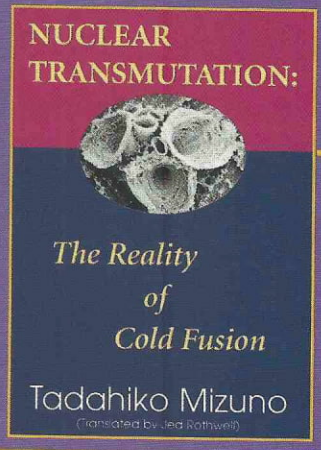

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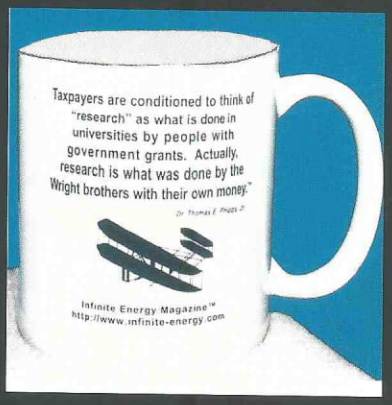

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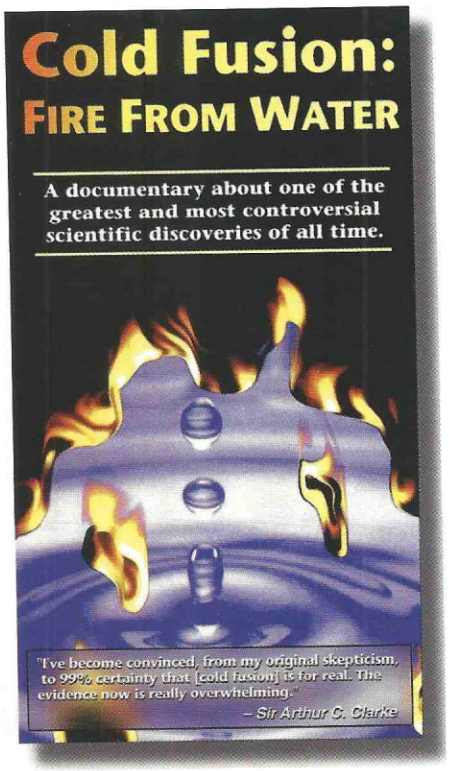
Cold Fusion:
Fire From Water



This informative documentary, produced in 1999, is narrated by James "Scotty" Doohan (of "Star Trek"). It features cold fusion scientists from around the world discussing cold fusion history and current research. Find out what has happened in the cold fusion field since the Utah announcement by Pons and Fleischmann in March 1989.

$34.95 North America
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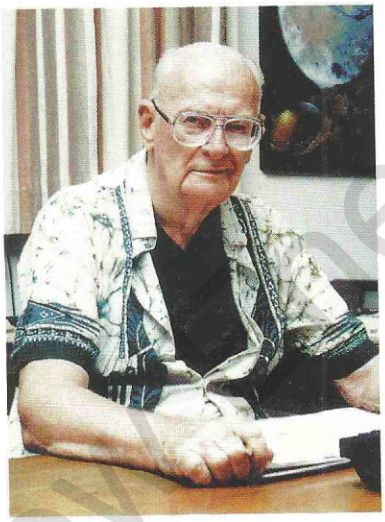


"It could be the end of the fossil fuel age: the end of oil and coal. And the end, incidentally, of many of our worries about global pollution and global warming."

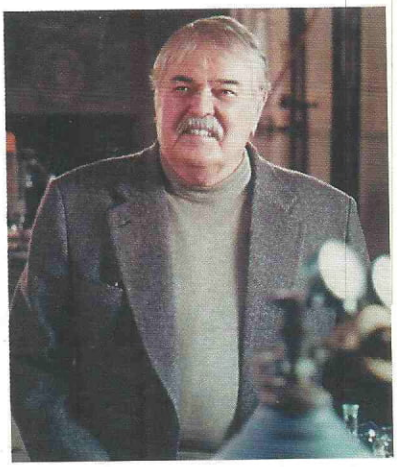
–Sir Arthur C. Clarke

Scientists featured in this documentary:

Dr. Jean-Paul Biberian • Prof. John O'M. Bockris
Dr. Benjamin F. Bush • Prof. Robert T. Bush
Dr. Les Case • Sir Arthur C. Clarke
Dr. Thomas Claytor • Dr. Martin Fleischmann
Dr. Lou Furlong • Prof. Peter Hagelstein
Dr. John Huizenga • Prof. Nathan Lewis
Sir John Maddox • Dr. Eugene F. Mallove
Dr. Douglas Morrison • Dr. Keith H. Johnson
Dr. Yan R. Kucherov • Prof. Xing Zhong Li
Dr. Melvin Miles • Dr. George Miley
Dr. Randell Mills • Prof. Richard A. Oriani
Dr. Thomas Passell • Dr. James Patterson
Dr. Stanley Pons • Robert Shaubach
Dr. Mahadeva Srinivasan • Roger Stringham
Dr. Edmund Storms • Prof. J.P. Vigier

Narrator: James Doohan

Writers: Dr. Eugene F. Mallove and Jed Rothwell
Producer/Director:
Christopher Toussaint (Free Spirit Productions)



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